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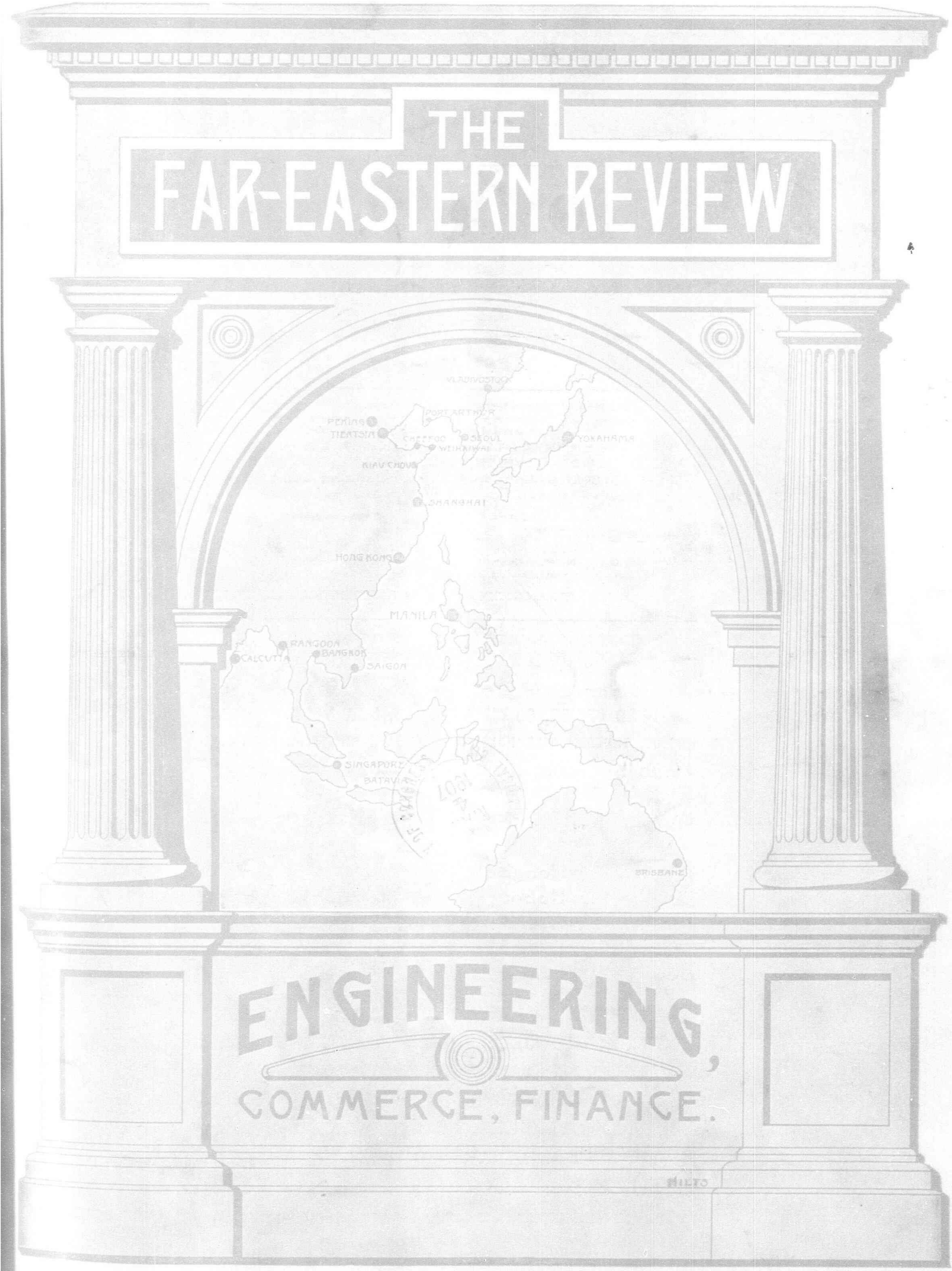

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ENGINEERING, COMMERCE, FINANCE.

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THE FAR EASTERN REVIEW
COMMERCE ✤ ENGINEERING ✤ FINANCE

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METHODS AND PRACTICE IN THE DESIGN OF REINFORCED CONCRETE

With Special Reference to Tropical Conditions in the Orient

(By J. C. KOCH, Assistant Engineer, Bureau of Public Works, Manila)

[*The practical design of arches and notes on reinforced concrete construction will be the subject of a second paper by Mr. Koch, which will appear in the February number of* THE REVIEW.—EDITOR'S NOTE.]

The limits of this paper forbid a complete discussion and comparison of the various theories and methods of calculation in the design of reinforced concrete structures, its main purpose being to set forth briefly and clearly the methods employed by the writer to meet conditions in the Philippines, with special reference to the design of beams, floor-slabs, T-beams and arches.

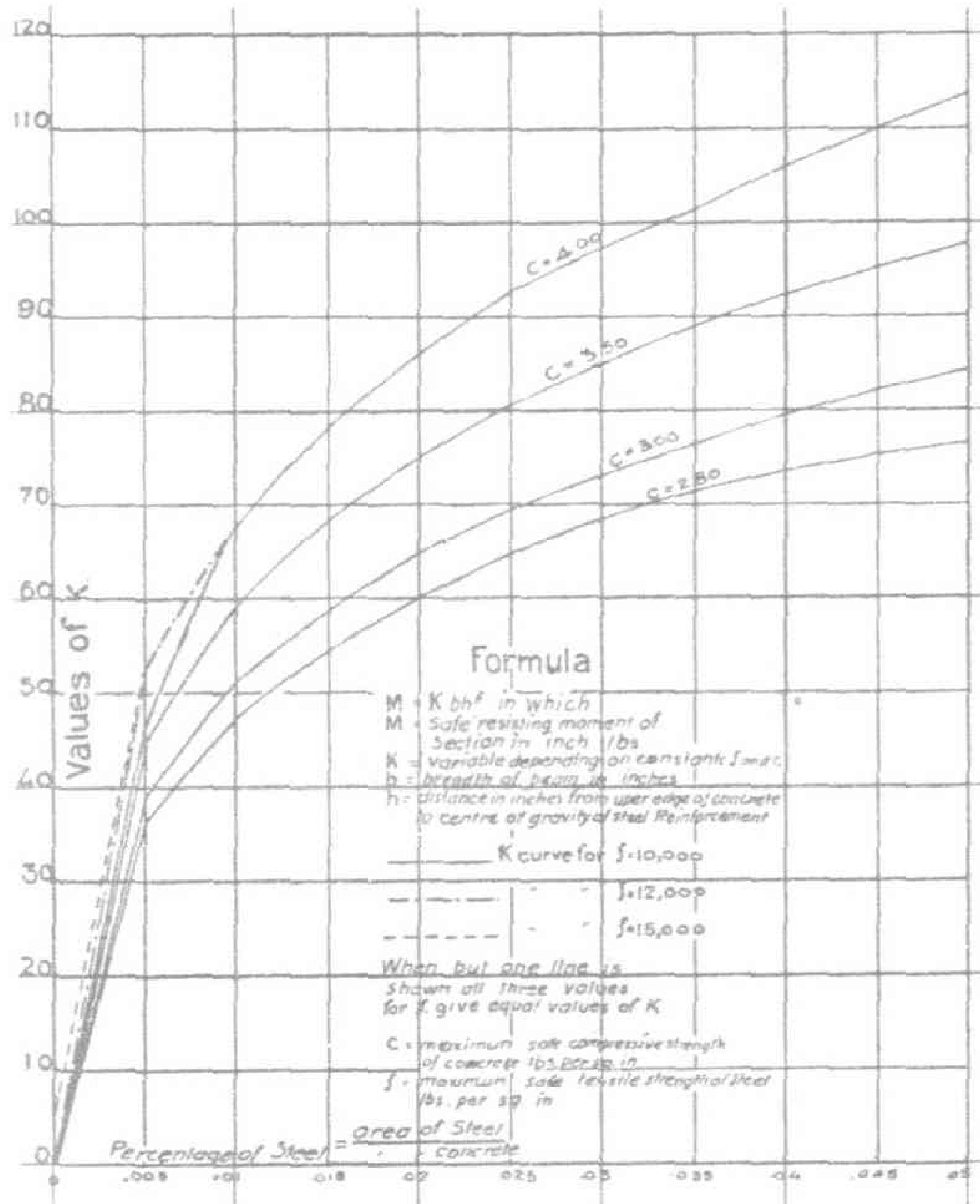

Diagram for values of K when $\frac{E_s}{E_c}$ 7.5, U=1

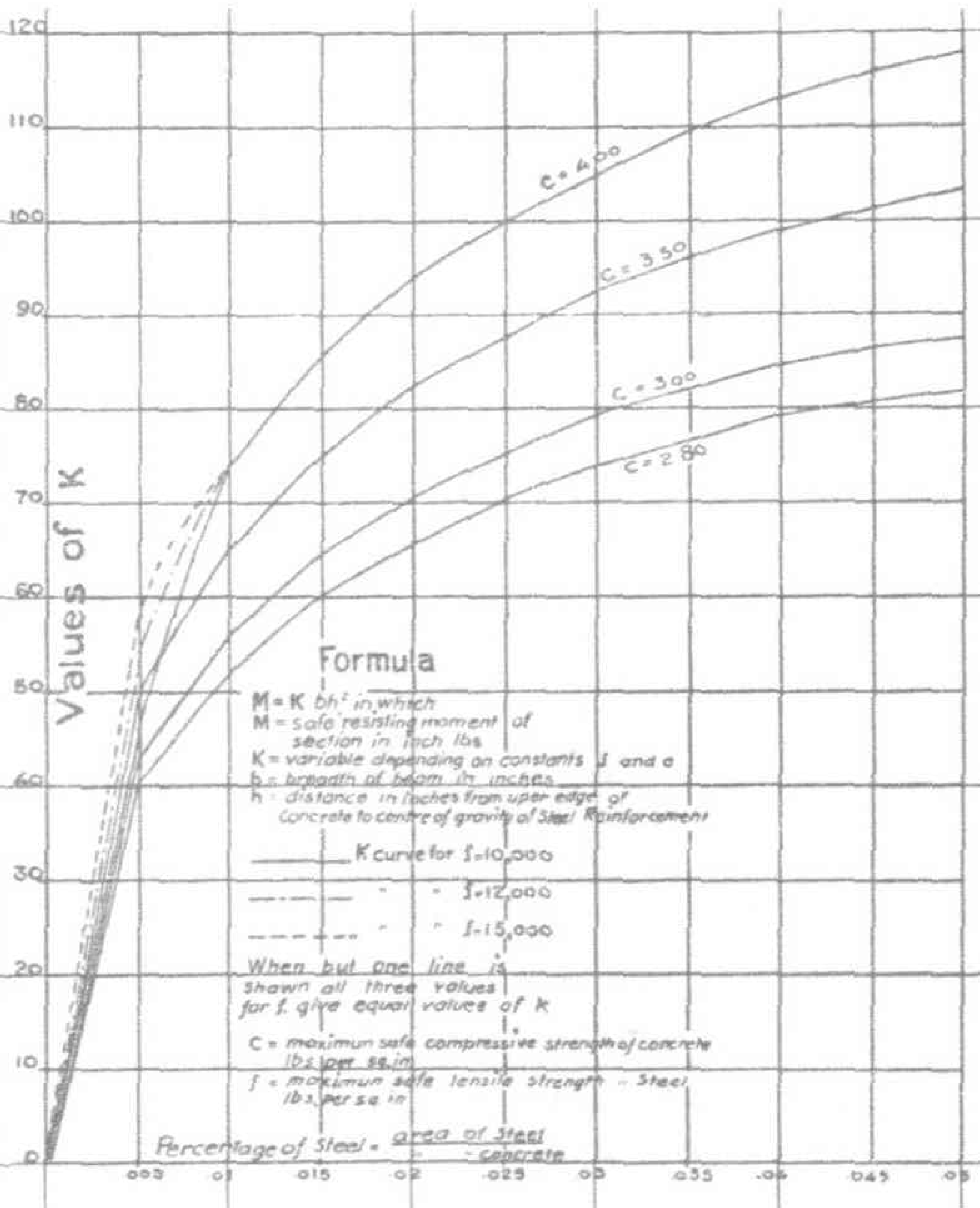

Diagram for values of K when $\frac{E_s}{E_c}$=10, U=1

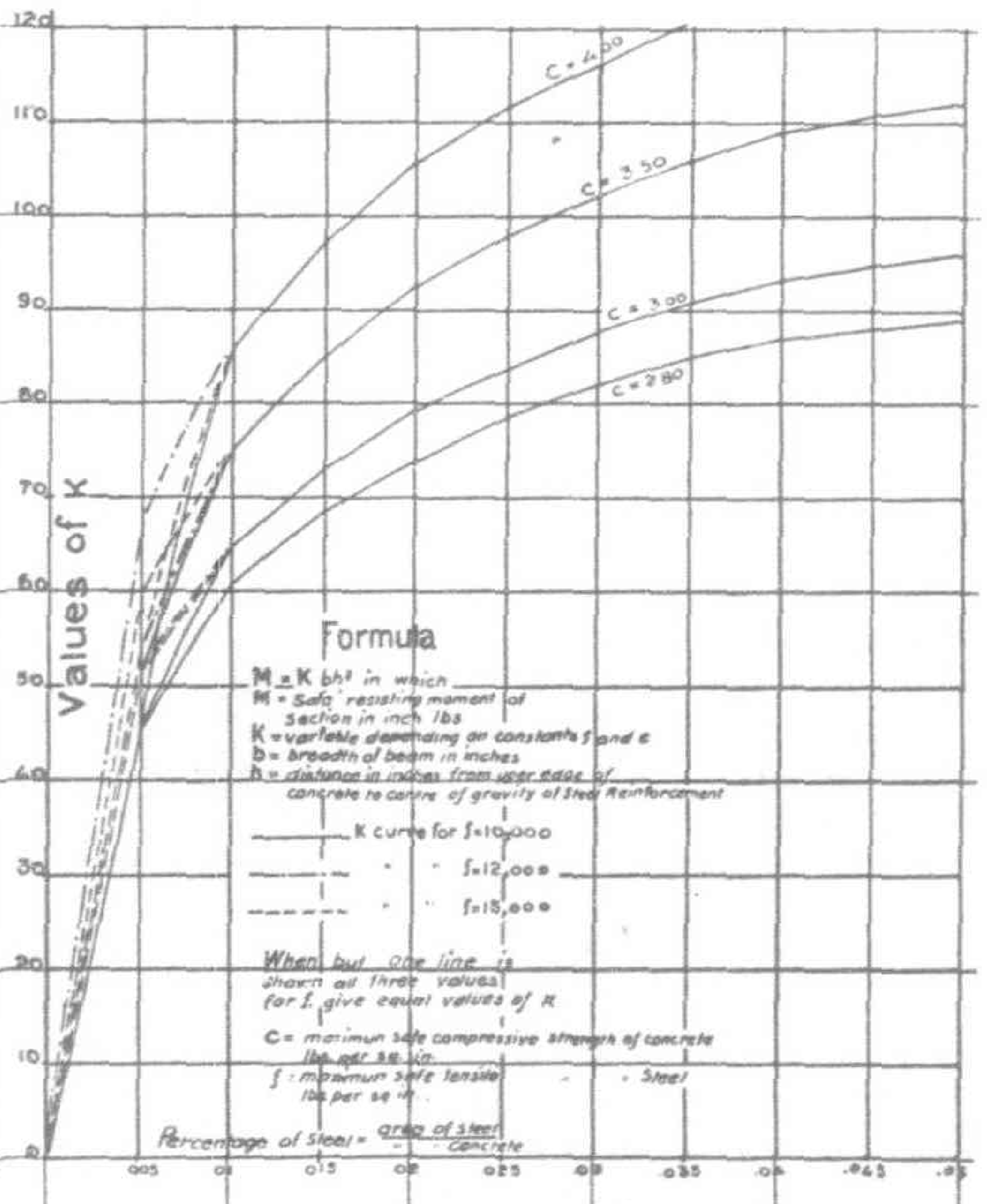

Diagram for values of K when $\frac{E_s}{E_c}$=15, U=1

The conditions prevailing in the Philippine Islands and practically throughout the Tropics, the alternating wet and dry seasons, destructive insects, luxuriant vegetation and high humidity, render the use of timber commercially available not only expensive, but in such exposed structures as bridges, really dangerous. In a structure where the wood is not exposed to the weather the white ant and other insects may eat into the wood and weaken it enough to render it unsafe in a few years. The few varieties of wood proof against these insects cost from $100 to $150 gold per 1,000′ board measure, and the supply is limited.

The stone commonly used for building purposes is usually a very poor, soft limestone called *adhobie* which often is about as expensive as concrete.

Steel constructions, unprotected, rust rapidly unless carefully painted about every two years, and as they are of comparatively short life in the Tropics even when carefully painted they cannot be considered as permanent work.

In the quest for a permanent building material concrete was considered and used to some extent by the Spaniards, but plain concrete, up until a decade ago, was rather expensive and until the price of cement was reduced, its use in the Philippines was extremely limited. But with the advent of cheap cement and cheap steel there was ushered into the field of construction a new material combining permanence with flexibility of application.

Usually the terms *concrete-steel* and *steel-concrete* are used interchangeably and equivalent in meaning to reinforced concrete. Sometimes a distinction is made in using the term steel-concrete to apply to constructions of steel and concrete in which the concrete does not serve any other purpose than that of protecting the steel from rust and rendering it more thoroughly fire-proof. In the construction of river-walls and cut-stone bridges there are many examples of steel bars being used to tie adjacent stones together to secure additional strength. The same principle is employed in reinforced concrete or concrete-steel as it is sometimes called. The advantage gained is that the steel is embedded in the body of the concrete and protected from the weather. Use is also made of the adhesion between the steel and the concrete to make the entire mass act as a homogeneous material. In beams the fibers of the upper half are in compression and those of the lower half are in tension. The compressive resistance of concrete is about 10 times its tensile resistance while steel has practically the same strength in compression or tension. Steel will carry in compression about 40 times as much load as an equal section of concrete, and in tension steel will carry about 350 times as much load as an equal section of concrete. The cost of steel is about 50 times the cost of an equal volume of concrete. So that for a given load in compression concrete will cost only about four-fifths as much as steel. But in tension to carry a given load with concrete would cost about seven times as much as to carry it with steel. By combining these materials so the concrete carries compressive load and the steel tensile loads greater economy is obtained than by using either material alone. One of the most important advantages gained by such a combination is the absolute protection of the steel against corrosion. Numerous cases are on record proving conclusively that the protection of the steel by concrete is perfect.

When properly designed, reinforced concrete is an economical material for floors, girders, walls, arches and almost every class of building construction.

Natural and slag cements do not make suitable concrete for reinforced concrete. The only class of cement that should be used for such work is a good grade of Portland having a tensile strength neat per square inch at the end of seven days of not less than 450 lbs.

A number of tests of briquettes made of a class of sand frequently used for concrete throughout the islands gave the following results:—Briquettes, 1 part cement, 3 parts sand, water 12.5 per cent of weight of cement and sand, at end of eight days, compressive strength per sq. in. 715 lbs., tensile strength same age

(Continued on page 242.)

THE FAR EASTERN REVIEW

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FREE ENTRY FOR RAILWAY MATERIAL

Under the act of the Philippine Commission which granted the franchises to the White and Speyer syndicates for the construction of certain railroads in the Islands, provision is made for the duty-free entry of all material required for building and operating purposes. As to direct importations by the engineering contractors to the Philippine Railway Company and by the Manila Railroad Company, the law is clear enough; but whether duty-paid stocks in the stores of the local hardware merchants, or those held in bond by these same merchants, can be construed to come in for the benefits of the act is a question which Commissioner Forbes, Secretary of Commerce and Police, now has under consideration. We have discussed this phase of the matter with several firms and we believe there is much merit in the position they have assumed. We believe they should be allowed to compete for this business with other markets of the Orient which are supplying the railways with large quantities of small material that the local firms have on hand, but whose prices the latter are not able to meet or underquote on account of the tariff wall. With this obstacle removed, they claim that they will be able to compete on a most satisfactory basis for the trade. We know of one Manila firm that brought over from the United States in anticipation of this very business a stock of small railway material and construction implements valued at $100,000 gold. These goods were placed in a bonded warehouse and there they remain because the firm is unable to compete with the Hongkong and Singapore markets, from which places large shipments of material are constantly coming into the Philippines duty-free. If the Government, however, will so amend the tariff clause of the act as to give the firm an opportunity to enter the competition it will be in position to do business. It seems to us only fair that local merchants should be allowed to sell these goods they have in bond, to the railroad companies, on the original invoices under which they were imported and with all the benefits of the duty-free clause of the law; and where other goods on which duties have already been paid are carried in stock and sold from the store shelves to the railroad builders the Government should make refunds of the duties already imposed. The local merchants claim that with these concessions from the Government they will be able to meet the foreign competition and by so doing keep at home large sums of money that are now being diverted to other nearby markets. Those in charge of the railway construction would be perfectly willing to place these orders in the Manila market—prices being lower or even as low as those quoted elsewhere—because they would be assured of prompt delivery when the demand for material is immediate. In the interest of the merchants the Commission should give this question the favorable consideration which we believe its importance to the local commercial field demands. The Manila merchants who are interested should bring all their combined influence to bear to the end that the Commission may clearly see the justice of their contention and the far-reaching benefits to be derived by the Islands in keeping as much of this railroad money at home as possible. We are all beginning to regard these railway enterprises as our own private concern, and it is due to us that we should derive every financial benefit from them that their construction offers. We are the people who later on will have to make them a commercial success, so whatever comes to us in the shape of patronage during their construction will of necessity be returned to the companies a hundredfold in times to come.

LUMBERING IN THE PHILIPPINES

Other pages of this issue of THE REVIEW are devoted to data regarding mechanical tests, properties, and uses of thirty Philippine woods; and the sawmills, lumber market and prices in these insular possessions. The facts thus set forth are of importance to other tropical countries of the Orient, because what they establish along general lines relative to the forestry of the Philippines may, in large measure, be used as the basis of similar studies elsewhere. Many of the woods under consideration abound in other countries and dependencies of the Far East, so that the conclusions arrived at here would be reached after a careful study of the timbers that grow in the forests of other tropical possessions in this section of the world.

With reference to the opportunities for lumbering in the Philippines, Major George P. Ahern, U. S. Army, Director of Forestry, gives some interesting data. The Philippine public forests cover an area of more than 40,000,000 acres, while less than 500,000 acres of forest are held by private owners Under an act of Congress in 1902 the Philippine forests can not be sold, leased, or homesteaded unless they are more valuable for agriculture than for forest purposes. Exclusive licenses may be granted for terms up to 20 years, and these give the holders the sole right to exploit certain forest products. The extent of the territory thus granted depends upon the size of the plant to be installed. No charge is made for such a license and only stumpage charges are imposed. These charges range from ₱0 50 to ₱2.50 per cubic meter, or approximately from $1 to $5 gold per 1,000′ b. m. Such an arrangement is believed to be preferable to buying the land, since no land taxes are incurred. There are no export duties on timber or on the manufactured product, and logs imported into the United States are admitted free. The import duty at Manila on sawmill and logging machinery is 5 per cent *ad valorem*. Freight rates from Manila to the Pacific Coast amount to $7 gold per ton (logs), about 40 cubic feet, or $12 to $14 gold per 1,000′ b. m., or $8 per ton of 40 cubic feet; light-weight material, $5 per 40 cubic feet. The distances to market are as follows:—

Distance from—	Manila.	Cebu.	Iloilo.	Hongkong	Shanghai.	Sydney.
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Seattle, U. S. A.	6,400	......	......	6,300	6,200	6,800
Cadiz, Negros Occidental	400	140	70	800	1,200	3,370
Bongabon, Mindoro	200	......	......	700	1,200	3,570

The amount of lumber used in the Philippine Islands per year is approximately 100,000,000 board feet. The amount of American pine used in China during the past year was 85,000,000 board feet, and that used in Australia during the same period 63,000,000 board feet. Common Philippine timber as good as American pine can be laid down at tide water for about the same price as pine on the Pacific Coast. Difference in freight rates, low stumpage, and cheap labor should combine to make a low rate on the manufactured Philippine product in the Chinese and Australian markets and should gradually replace the American product.

The actual stand of timber on tracts in Negros and Mindoro shows 10,000 to 32,000 board feet per acre. The lower slopes of Mount Silay in Northern Negros are practically covered with merchantable timber over 20″ in diameter. A large area of similar forest on Mount Silay adjoins this tract and awaits the lumberman. In the southwestern part of this province (Negros Occidental) is a large area of valuable forest which will be close to the southern terminus of the new railway that is not under construction. There are a number of regions in the Philippines where dense forests of valuable timber are found which have never been exploited for the market. The Agusan Valley, in Mindanao, 4,000 square miles in area, is almost entirely covered with virgin forests and drained by large streams. The dense forests on the east coast of Mindanao are also unexploited.

Labor for this industry is *not difficult* to secure. The wages range from ₱0.50 to ₱1.50 ($0.25 to $0.75 gold) per day. Filipinos are apt at handling machines of all kinds and work satisfactorily when treated with consideration. Skilled loggers and lumbermen, assisted by Filipino crews, should get out logs and manufactured material at prices not far from those quoted for pine on the Pacific Coast, especially in regions where we find 30,000 board feet of merchantable timber on each acre close to tide water, and where no special logging difficulties are encountered.

Logging is carried on during the entire year in many of the provinces. In some places it is suspended during the seasons of heaviest rains, a period of from two to four months. The present logging methods are very crude. Many of the native woods will float, and, if handled by the expert raftsmen of the Pacific Coast, could be rafted 200 to 600 miles through the quiet inland seas to Manila, and possibly to China.

No lumbering enterprise, however, should be attempted in the Philippines unless the company intends to handle the product from start to finish, including transportation, lumberyards at the principal markets, supply stores for use of the employés in the forest, etc. This would probably involve the employment of not less than $200,000 gold.

JAPANESE AND INDIAN COAL MARKETS

Japan is at present India's only real competitor in the coal markets of the Far East; but considering the difference in the extent of the coalfields of India and those of Japan, it is reasonable to conclude that the day is not far off when India will control the Oriental coal markets. The conclusion is based on the fact that Japan has but 6,000 square miles of coalfields. Her present annual output is about 10,000,000 tons, which is in excess of the Indian mines, but this is a small tonnage compared with what India is capable of producing. The latter has the coal, abundant cheap labor, and the capital; also convenient water transportation to the sea. The hauls by rail are short and comparatively inexpensive. This service is being supplied as rapidly as possible to meet the demands of the inland trade.

In referring to the coal future, the Chief Inspector of Mines for India observes that the chief need for a sound development of the Indian coalfields is improvement in superintendence and working capacity of the miner. The methods of working the mines are crude and unscientific, and this results in not only a smaller output than should be expected but also in a great waste. To overcome this condition the Government of India has established a college, which has a large attendance, at Sibpore, for the scientific training of native engineers with special reference to coal-mining. It is believed that the classes at this institution will furnish the needed skilled assistants to foreign superintendents.

The Indian miner performs work underground much as the Indian laborer does on top of the ground. Whatever kind of labor he undertakes he brings to it an easy-going manner and bone and muscle that are far inferior to that of the English miner or the miners of America. In fact, he accomplishes less than half the results of the western miner. He has not the physique, having inherited small bones, light muscles, and an *easy way* from his ancestors. It is believed, however, that he is growing stronger and becoming more capable, and that in time the coal miners of India will by heredity become almost equal to coal miners anywhere, at least to those of Japan.

In connection with Indian coal-mining, the American Consul-General at Calcutta says there is one thing to be deplored, and that is the employment of women in and about the mines as laborers. Some of these coolie women are said to walk 5 miles a day in the performance of their work, and carry on their heads loads of 50 lbs. half that distance. There is a strong sentiment growing against this sort of drudgery for women, but indications are it will be a long time before the Indian women will be delivered from such toil. Yet this practice of employing female labor in mines is not confined to India alone. The mines of China and Japan employ their quota of coolie women, who labor day in and day out alongside their husbands turning out as much work in many cases as their stronger and huskier liegelord ever thought of doing. It has not been so many years since women and children were rescued from such drudgery in other countries, but such a reform in the countries of the Orient appears to be far off at the present.

In Calcutta, the capital of India, the coolie women carry bricks and mortar on their heads and climb bamboo ladders to the third and fourth stories of buildings as helpers to coolie masons. They carry on their heads burdens seemingly large enough to bend the backs of bullocks and donkeys. Even girls of 8 and 10 years of age carrying loads on their heads weighing 50 lbs. and more and trudge along under the sun's intense rays with the mercury rising to 100 degrees in the shade. Yet neither is this an unusual condition in other parts of the Orient. The coolie women of China till the soil, work on the railroads and other construction enterprises, clean the public streets, and on the rivers furnish fully three-fourths of the sampan and light junk labor. In many parts of Japan and Manchuria this identical social condition prevails, in many of the seaports of the former country the women adding to their sphere in the field of labor the coaling of vessels with baskets.

Another fact about female labor which appeals to reformation is that the women receive only about one-half the pay of the men. No matter how hard they work nor how long the hours —a day usually means from sunrise to sunset— the wage is the same, and a mere trifle at that. Throughout China the male laborer will receive on an average $0.20, Mexican currency, *per diem*, while the female on the same job and accomplishing an equal amount of labor gets $0.10 Mexican currency a day. This rule seems to be general throughout the Orient, and while it means a large saving of money for the employer in a year it seems to carry with it a certain inhumanity that can not appeal to the western favorably.

MANILA RAILWAY COMPANY, LTD.

Elsewhere in this issue appear the details of the reorganization scheme of the British directors of the Manila Railway Company, Ltd., which the shareholders in that corporation have adopted. An interesting feature of the report is the announcement that Mr. Horace L. Higgins, who has been the moving spirit of the Manila & Dagupan Railway since its inception, has accepted the office of President and General Manager of the Manila Railroad Company, the American concern which takes over the interests of the British Company in the Philippines, and in addition will build and operate the new railway lines on the Island of Luzon for which Messrs. Speyer & Co., of New York, are the original concessionaires under Government franchise. Mr. Higgins is regarded by the American engineers who have assembled here to expand other large railway projects a most valuable advisor in many of the difficulties that are met with here in connection with railroad building. This high esteem is not confined to the engineers alone, but it is shared with an abiding confidence by the Government of the Philippine Islands which not infrequently calls upon Mr. Higgins for advice and guidance over knotty railway problems. The distinguished favor which Mr. Higgins always enjoyed in the conduct of the affairs of the Manila Railway Company, Ltd., was his best recommendation to the Speyer Syndicate. Judging from his thorough knowledge of local conditions, his large engineering ability, and his keen conception of the task in hand together with his well-known sagacious business ability, we feel safe in the opinion that the interests of the Manila Railroad Company will be promoted by its new President and General Manager. Mr. Higgins is not making much ado over the progress of his new construction work on Luzon, but his forces are accomplishing results along all routes of extension.

The reconstruction scheme of the Manila Railway Company, Ltd., provides for the adjustment of the various claims of the British interests against the Washington and Philippine governments, and, at the same time, will put the company upon what, it is asserted, will be a paying basis. The concession held by the old company from the Spanish Government has given place to the concession from the American Government to the new company, which is described as being more favorable in several respects, besides which the concession includes powers for the construction of many additional miles of railway. In their circular the directors say that when the plan is fully carried out the position as regards the railroad system will be that, instead of being operated under a concession for a limited period, at the expiration of which the property would revert to the Government, it will have the benefit of the unlimited concession, or perpetual franchise; also of a very substantial reduction in taxation, while the menace of a claim on the part of the Government under the terms of the old Spanish concession to a share in the net earnings will be removed. The directors have confidently recommended to the shareholders and the various security holders the scheme they propose, believing that it affords the best, if not the only, solution of the many difficulties which have confronted the company. And they add that, however content under the improved conditions of their property the security holders might be to continue without any change in their position, it is practically impossible for them to do so without sacrificing very substantial benefits which are now obtainable.

CHINESE ENGINEERING AND MINING COMPANY, LTD.

According to *The Celestial Empire* the fifth annual meeting of the Chinese Engineering and Mining Company, Ltd., shows that great improvement has been made as to the position and standing of the company, and it shows also that arrangements have been made for largely increasing the output of coal at the Kaiping mines. The chief features of the financial year of the company are that it has been able to maintain the dividend of 10 per cent, to make ample reserves, reducing the debenture issue by the sum of £10,500. The debenture issue has now been reduced by £78,540 from its original £500,000. The demand for the company's coal has been fully maintained, but there has been a diminution in the output. The situation throughout the year has been that the company has been unable to keep pace with the demands for coal, and that consequently it has been working without any margin in the way of stock. Three years ago the stock of coal had risen to such a large extent that the company was anxious to reduce it. The best proof of the progress of the company is the development of its business, and the best augury for the future is that notwithstanding the fact that the output during the year under review was considerably larger than it was a few years since, it was practically sold out at the end of the year, and the demand for coal was practically in excess of the supply. The gross profit and loss for the year is £178,580, which shows a reduction of £25,000 compared with the previous year. This is due to the diminished output and the consequent diminution of the sales and also to the somewhat increased cost of production, but the reduction does not cause the directors any misgiving, as it was of a transient nature and the results for the year are satisfactory.

The total profits for the year amount to £144,447, out of which £10,000 were expended for the redemption of debentures and £30,000 were carried to the reserve for depreciation account, which bring up the reserve to £110,000. The balance remaining, £104,447, with £8,199 brought forward from the previous year, make an available total of £112,646. One shilling per share was paid on May 1st as an interim dividend, and 1s. on November 2d, making 10 per cent for the year, leaving a balance of £12,646 to be carried forward to next year's account. The company has to the credit of reserve for depreciation account £110,000 to the credit of reserve for the redemption of debentures £31,666, and to the credit of exchange account £43,272, making a total of about £185,000.

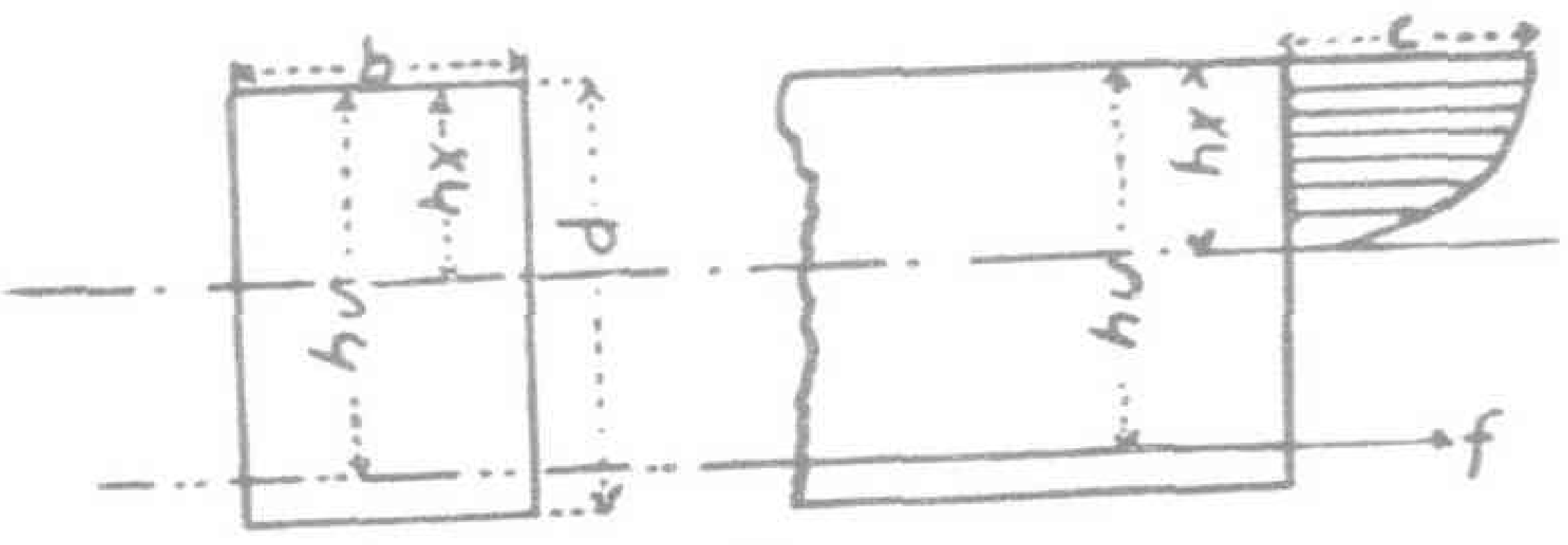


Fig. 1.

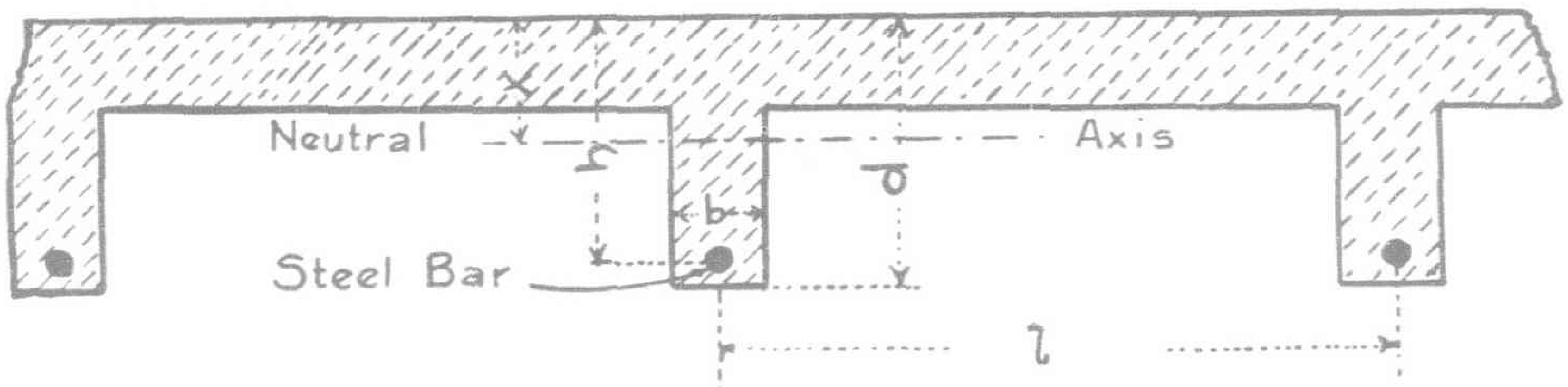


Fig. 2

METHODS AND PRACTICE IN THE DESIGN OF REINFORCED CONCRETE

(Continued from page 239.)

125 lbs. per sq. in. For standard No. 20 quartz briquettes of same age and proportions the compression strength per sq. in. was 1590 lbs. and the tensile strength 243 lbs. per sq. in. The conditions under which all these briquettes were made were uniform throughout. The sand used in the above tests was a very fine material containing about 3 per cent of earthy matter. About 50 per cent of this sand passed a No. 40 sieve and 98 per cent passed a No. 30 sieve. If possible all sand samples should be graded. If practically all the grains are finer than No. 30 and about the same size it should not be used, or if used, it should be mixed with a coarser sand so that not more than 30 per cent of the grains are of any one size. Of course the sand should be clean and sharp, though it is usually difficult to get sharp sand in most localities.

These tests also tend to show that the materials in use in some parts of the Philippines are inferior to those commonly used in reinforced concrete work in the United States. The high constants in use in the United States in the design of reinforced concrete have been found too high for the class of workmanship and materials usually encountered in the Philippine Islands. For this reason the writer proposes the use of constants much lower than those ordinarily used in the United States.

In designing any important work tests in tension and compression should be made of briquettes made of the same sand and cement as is proposed to be used in the actual construction and not more than one-fifth of the ultimate strengths at the end of 30 days should be taken as the safe working stress.

In the absence of suitable compression testing apparatus the briquettes should be tested in tension and the safe compressive strength taken at not more than 10 times the safe tensile strength at the end of 30 days.

CONSTANTS.—The writer proposes the following constants for use unless direct tests show that higher ones may be used safely. All constants are based on concrete 30 days old and safety factor of 5:—

1-2-4 concrete in tension 30-40 lbs. per sq. in.
1-3-6 concrete in tension 28-35 lbs. per sq. in.
Shearing strength of concrete 40-60 lbs. per sq. in.
1-2-4 concrete in compression 300-400 lbs. per sq. in.
1-3-6 concrete in compression 280-350 lbs. per sq. in.
Mild steel in tension 12,000 lbs. per sq. in.
Modulus of elasticity of 1-2-4 concrete 2,500,000.
Modulus of elasticity of 1-3-6 concrete 2,000,000.
Modulus of elasticity of steel 29,000,000.
Ultimate strength of steel 57,000 and 65,000 lbs. per sq. in.
Elastic limit of steel 55 per cent of ultimate strength.
Safe working adhesion between concrete and steel 40-80 lbs. per sq. in. of metallic surface.

The small range of temperature makes it unnecessary to provide for temperature stresses in ordinary structures.

DESIGN OF BEAMS.—The steps in the proper design of a beam should be taken in the following order:—(1) Determination of maximum bending moment due to external loads; (2) computation of section needed to resist such bending moments with the required factor of safety. Computation of bending moment due to weight of beam itself and increase of section if necessary; (3) the determination of longitudinal shear between the steel and concrete and provision of mechanical bond if safe adhesive strength is exceeded; (4) the determination of vertical shear and introduction of properly located shear-bars if the safe shearing strength of the concrete at any point is exceeded.

FORMULAS.—The rapid extension of the use of reinforced concrete in the past few years has resulted in the development of many formulas for the design of the various parts of such structures. The most economical use of reinforced concrete members being in positions when they are subject to transverse stresses, as in beams and floor slabs, most of the formulas are for beam design. Many of these formulas are based on more or less rational theory while others are absolutely empirical. As with most empirical formulas, the empirical formulas in use for the design of reinforced concrete are quite simple in form and application. As they contain constants which to a large extent offset the manifest errors in the assumptions upon which they are based, they are in quite extensive use. In experienced hands empirical rules do not usually lead to disastrous consequences.

The rational formulas appear rather complicated and forbidding and for that reason are not used as widely as they should be. The formulas used by the writer for more than two years in the design of beams admits of greater flexibility in conforming to the conditions prevailing here, and combine the advantages of being based on rational theory and of simpler form than most of the empirical formulas. It is quite evident that an empirical formula based on concrete having an ultimate strength in compression of 2,500 lbs. per sq. in. at the end of one month will have no application in a region where average concrete will have an ultimate compressive strength of from 1600 to 2000 lbs. per sq. in. at the same age. For this reason it is urged that all empirical formulas based on the high constants in use elsewhere be abandoned in the design of structures in the oriental Tropics where materials are usually so much inferior to those commonly used in the United States.

The theory is that given by Prof. W. K. Hatt of Purdue University after a long series of authoritative tests on reinforced concrete beams (*Eng. News*, Feb. 27, July 17, 1902). Quoting from this article, "the important fact is the increased extensibility of reinforced concrete in tension. Thus while plain concrete broke with an average extension of 1:7000 the reinforced concrete broke with an average extension of 1:1400. The effect of the reinforcement probably is to distribute the maximum elongation over the entire length of the beam, whereas in the case of plain concrete the maximum elongation is confined to the fractured section."

This analysis assumes a parabolic distribution of stress for compression in the concrete (based on numerous stress-strain diagrams), and a position of the neutral axis depending upon the ratio of the area of steel to that of concrete.

The theory is developed from the following assumptions:—(1) Sections plane before bending remain plane surfaces and hence the distor-

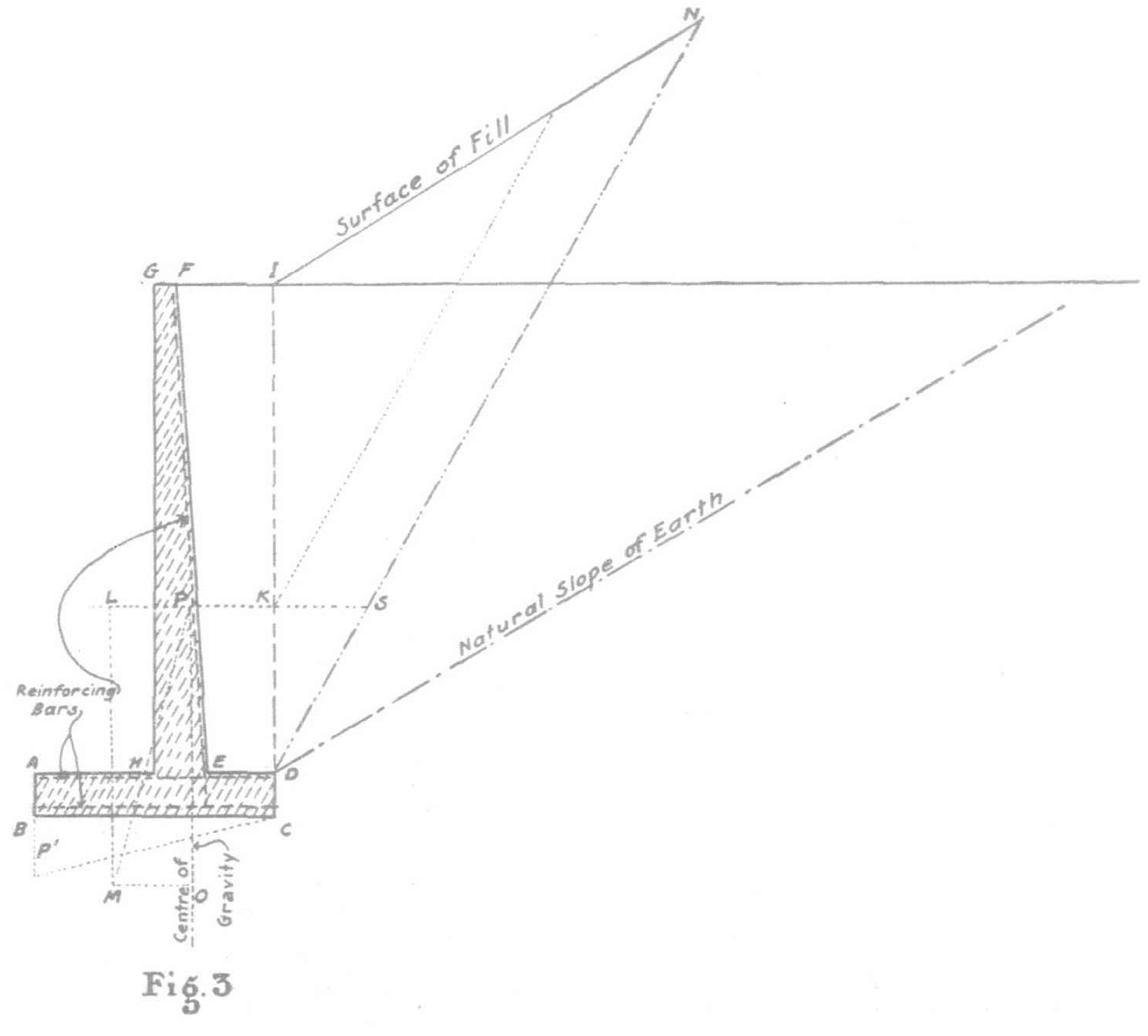
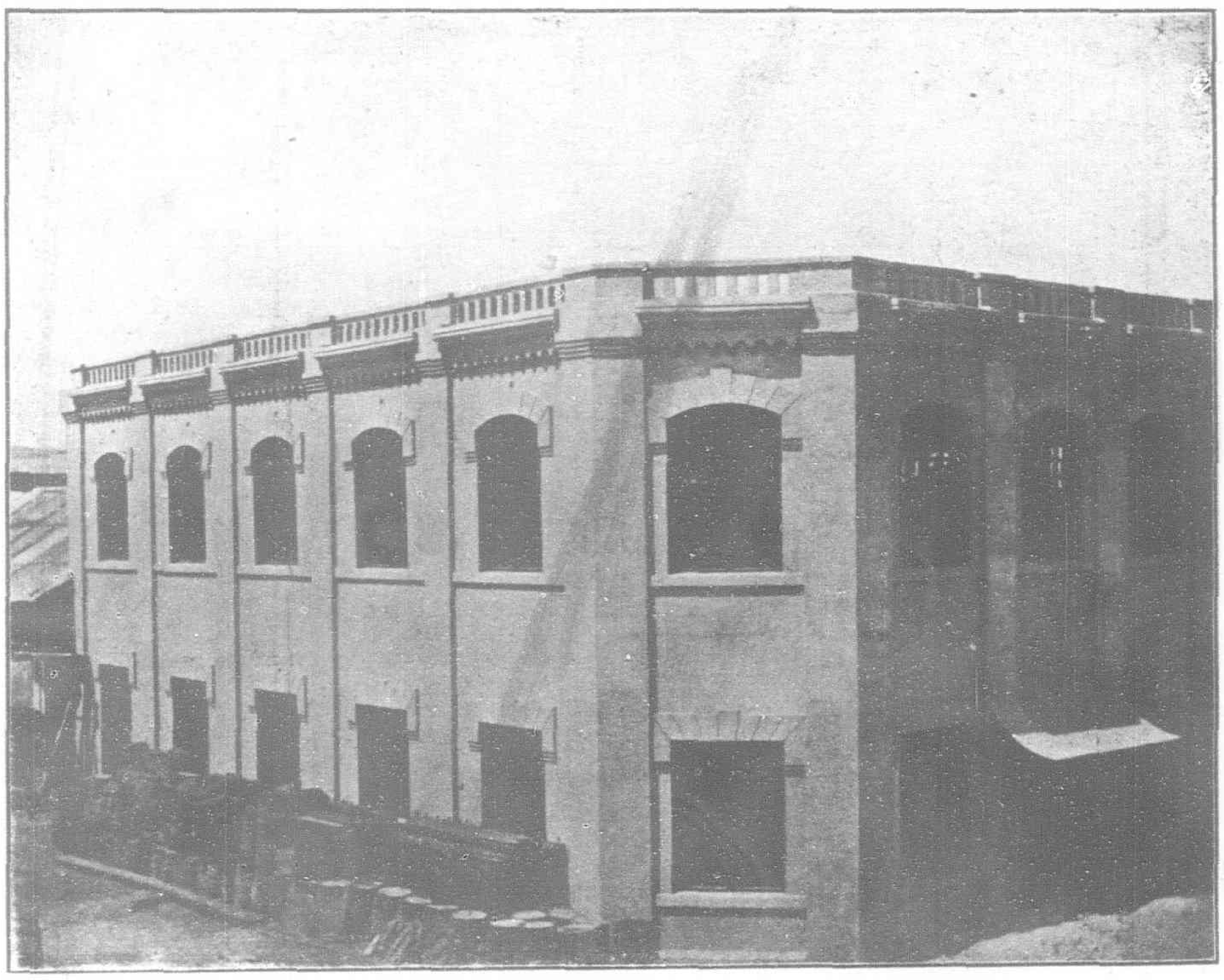


Fig. 3



REINFORCED CONCRETE BUILDING IN MANILA CONSTRUCTED BY THE ATLANTIC, GULF AND PACIFIC COMPANY

tion of any fiber is proportional to its distance from the neutral axis: (2) external loads are perpendicular to the neutral surface; (3) the values of moduli of elasticity obtained in direct tension and compression apply to steel and concrete when under stress in beams; (4) there is no slipping between the concrete and the metal; (5) the concrete is stressed in compression only and the steel in tension only; (6) there are no initial stresses in the beam due to contraction, removing forms before concrete has set thoroughly, etc.

In *Fig.* 1:—

Let d=total height of the beam in inches.
- b=breadth of beam in inches.
- h=distance from the center of the steel reinforcement to the upper edge of the concrete, in inches.
- hx=distance of compression face from neutral axis, in inches.
- u=1, then hu=h.
- p=ratio of area of steel to area of concrete $\frac{As}{Ac}$
- c=maximum safe compressive stress in extreme fiber of concrete.
- f=maximum safe compressive strength of steel in tension.
- Es and Ec=moduli of elasticity of steel and of concrete in tension and compression, respectively.
- M=bending moment or resisting moment.
- As=total area of steel in square inches.
- Ac= b h.

Since the steel takes tension only and the concrete compression only equating the tensile and compressive forces we have:—

$$\tfrac{2}{3}c\,x=p\,f \qquad (1)$$

From the first assumption we have

$$\frac{c}{Ec}:\frac{f}{Es}::h\ x:h\ (u\text{-}x)$$

and substituting equation (1) becomes

$$x^2=\frac{Es}{Ec}(u\text{-}x)\ p \text{ from which}$$

$$x=-\tfrac{3}{4}\frac{Es}{Ec}p+\sqrt{\tfrac{3}{2}\frac{Es}{Ec}p\left(u+\tfrac{3}{8}\frac{Es}{Ec}p\right)} \qquad (2)$$

Then taking moments around the neutral is the resisting moment is

$$M=b\,h^2\left(\frac{5}{12}c\,x^2+p\,f\,(u\text{-}x)\right) \qquad (3)$$

By an ingenious method proposed by Prof. L. J. Johnson (see "The Design of the Steel-Concrete Work of the Harvard Stadium," *Journal of the Association of Engineering Societies*, for June, 1904), the formulas given can be greatly simplified.

If the values of c and f from equation (1) are substituted alternately in equation (3) the latter becomes

$$M=\tfrac{2}{3}\,cx\,(u-\tfrac{3}{8}\ x)\ b\ h^2 \text{ if allowable stress in concrete is assumed.}$$
(4)
$$M=pf\ (u-\tfrac{3}{8}\ x)\ b\ h^2 \text{ if allowable stress in steel is assumed.}$$

Prof. Johnson then replaces the coefficient of b h^2 in equation (4) by "K," a numerical coefficient depending, for a given u and $\frac{Es}{Ec}$, simply on the steel percentage and can be taken from a table, or a diagram whose ordinates are the values of "K" and whose abscissae are values of p; the values of c, f and $\frac{Es}{Ec}$ being assumed constant.

Since we have taken u=1, and adopting the simplified form we have the following formulas for practical application:—

$$\tfrac{2}{3}\ cx=p\ f \qquad (5)$$

$$X=-\tfrac{3}{4}\frac{Es}{Ec}p+\sqrt{\tfrac{3}{2}\frac{Es}{Ec}p\left(1+\tfrac{3}{8}\frac{Es}{Ec}p\right)} \qquad (6)$$

$$M=K\quad b\quad h^2 \qquad (7)$$

In equation (7)

$$\left.\begin{aligned}K&=\tfrac{2}{3}\ c\ x\ (1-\tfrac{3}{8}\ x)\\ \text{or } K&=p\ f\ (1-\tfrac{3}{8}\ x)\end{aligned}\right\} \qquad (8)$$

depending upon whether the allowable safe unit stress for concrete or steel is assumed. If certain safe unit stresses for c and f are assumed and substituted in equation (8) the smaller value of K should always be taken, because the value of neither f nor c should be exceeded in equation (5), and whichever value of f or c gives the smaller value for either term of (5) should be used for solving for K in equation (8).

The constants to be assumed are p, $\frac{Es}{Ec}$, c and f. The value of p is optional, though the writer's experience has been that the most economical beams (concrete costing in place from ₱14 to ₱20 per cu. yd. and steel from ₱0.04 to ₱0.06 per lb.) have a ratio of area of steel to area of concrete of from 0.015 to 0.0125.

DIAGRAMS.—To facilitate the use of the formulas discussed above three diagrams have been prepared for obtaining easily and quickly the values of K for values of $\frac{Es}{Ec}$ of 7.5, 10.0 and 15.0 and each of these diagrams will give the correct values of K for c=280, 300, 350 and 400 and each of these for values of f=10,000, 12,000 and 15,000.

It will be noted that in all cases when the value of p=0.01 or greater the curves for f=10,000, 12,000 and 15,000 coincide. This is due to the fact that when p is greater than 0.01 the full safe strength of the steel cannot be utilized without exceeding the maximum safe unit stress in the concrete.

The depth h obtained by using the formulas is the distance from the upper edge of the concrete to the centre of the steel reinforcing rods. If there are two rows of bars h is taken as the distance from the upper edge of the concrete to the centre of gravity of the reinforcing. A safe rule for proportioning beams is to make d, the total depth of the beam, equal to h plus twice the diameter of the bars used for reinforcement.

EXAMPLE:—What is the safe uniformly distributed load with a safety factor of 5 that a beam 13.5″ deep and 12″ wide will carry in addition to its own weight, the clear span being 14′, the diameter of reinforcing bars being ¾″ and $\frac{As}{Ac}$ = 0.015, ultimate strength of concrete being 2.000 lbs. per sq. in.

For a factor of safety of 5 we take

$$c=\frac{2000}{5}=400$$

$$f=\frac{60{,}000}{5}=12{,}000$$

Since the total depth of beam is 13.5″, the distance from the upper edge of concrete to center of reinforcement should be 13.5—2 (¾) = 12.0″

This gives us the values

$$b=12''$$
$$h=12''$$

From our knowledge of the concrete to be used suppose we decide $\frac{Es}{Ec}$ for this particular case to be equal to 15.

From the diagram for $\frac{Es}{Ec}$=15 we find, following the curve for c=400 and f=12,000 and noting its intersection with the ordinate though p=0.015 we find a value of K=97.

Substituting this in formula (7) we have the safe resisting moment of the beam to be

$$\begin{aligned}M&=97\ b\ h^2 \quad \text{inch-pounds}\\ &=97\ (12)^3 \quad \text{inch-pounds}\\ &=13{,}968 \quad \text{foot-pounds} \quad (A)\end{aligned}$$

M for a uniformly distributed load of w per foot, the clear span of beam in feet being l, is

$$M=\frac{w\ l^2}{8}$$

Since l=14

$$M=\frac{196\ w}{8}=24.5\ w \qquad (B)$$

Equating A and B

$$24.5\ w=13.968$$
$$w=570 \text{ lbs. approximately.}$$

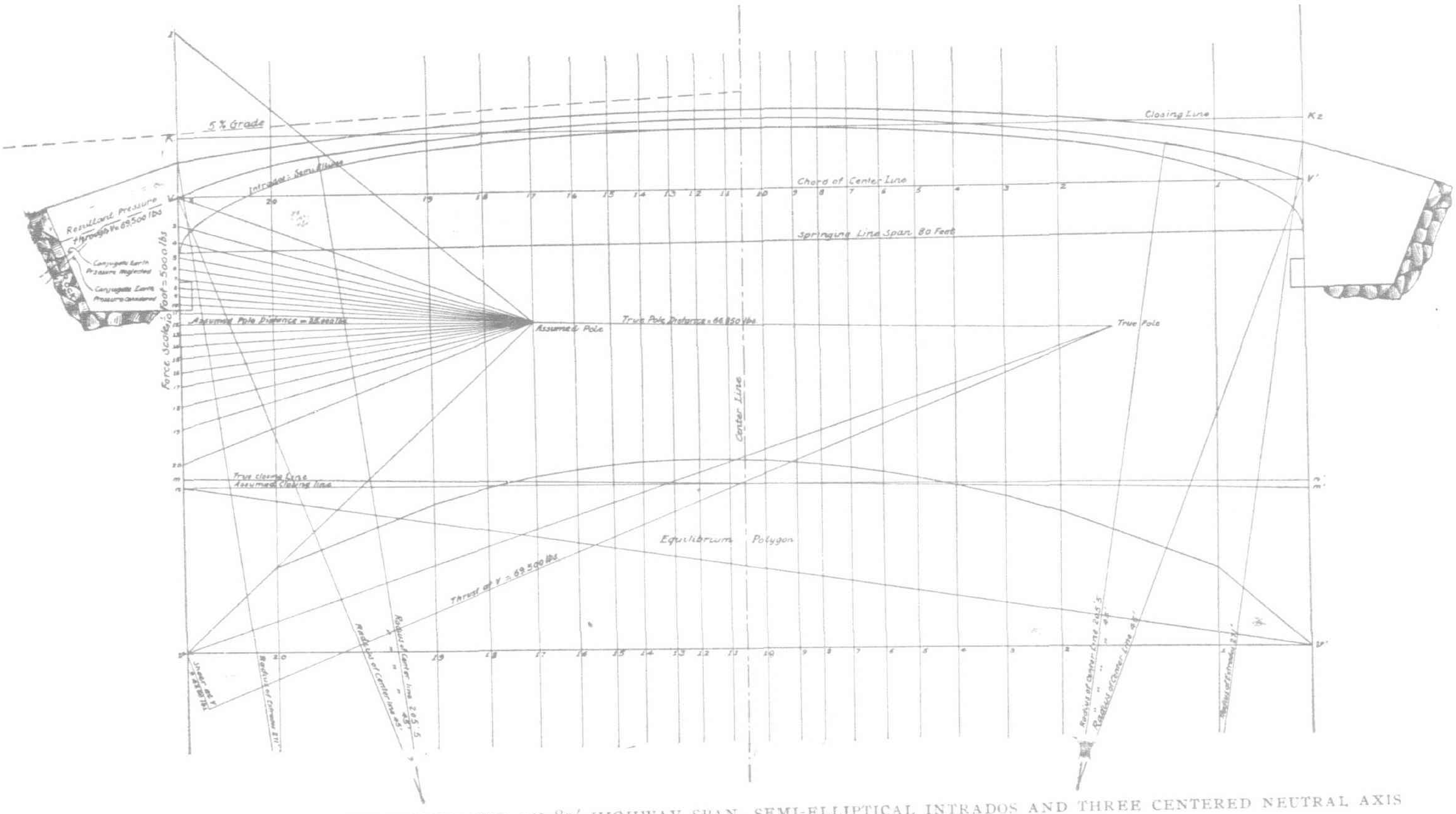
Since the section of the beam is approximately 1.12 sq. ft. in area, the weight of the beam per foot is about 160 lbs. Subtracting this from 570 we have the safe uniformly distributed load per foot of beam=410 lbs. or a total load on the beam of 5,740 exclusive of its own weight.

If $\frac{Es}{Ec}$ had been taken at 7.5 the total safe extraneous load, all other constants being unchanged, would have been 4,200 lbs. If $\frac{Es}{Ec}$ had been taken equal to 10 the total safe extraneous load would have been 4830 lbs.

In the design of beams when the loads are given and it is required to find the proper section of beam the inverse process is followed. Find K as before, the maximum bending moment due to extraneous loads is calculated and reduced to inch-pounds, and equated to K b h^2. If b is assumed a certain part of h say ½ h the equation becomes

$$\text{Safe bending moment in inch-pounds}=K\,\frac{h^3}{2}$$

K being known from the diagram h is found readily. To the value of h as found add twice the diameter of steel bars used for reinforcement and thus obtain the total depth, d, of the beam; and as b was assumed a part of h, when h is determined b is also known.


5 % Grade
Closing Line
K2
Chord of Center Line
Intrados: Semi Ellipse
Resultant Pressure through V = 69,500 lbs
Conjugate Earth Pressure neglected
Conjugate Earth Pressure considered
Springing Line Span 80 Feet
Force Scale 1/10 foot = 5000 lbs
Assumed Pole Distance = 38,600 lbs
Assumed Pole
True Pole Distance = 66,850 lbs
True Pole
Center Line
True closing Line
Assumed Closing line
Equilibrium Polygon
Thrust at V = 69,500 lbs
Radius of Extrados 211'
Radius of Center line 205.5'
Radius of Center line 45'
Radius of Extrados 211'
V'

GRAPHIC DIAGRAM OF ELASTIC METHOD FOR AN 80′ HIGHWAY SPAN, SEMI-ELLIPTICAL INTRADOS AND THREE CENTERED NEUTRAL AXIS

In the problem just solved the area of steel will be

$$.015\,(12 \times 12) = 2.16 \text{ sq. in.}$$

This will require $\frac{2.16}{.44} = 5$ bars ¾″ diameter.

The spacing will be $\frac{12''}{5} = 2\frac{1}{2}''$ c. to c.

FOOTINGS.—Footings for continuous walls may be economically designed in reinforced concrete. In such cases the reinforcement is placed at right angles to the horizontal axis of the wall. The maximum thickness of the footing slab will be just under the wall proper and from this thickness it will taper down to a thickness of 4 or 5″ at the extreme edges. The method of proportioning footings is to compute the pressure per sq. ft. that the soil under footing will receive, and then compute the maximum bending moment that will be exerted on the footing by treating it as a cantilever beam carrying uniform load (this being the upward thrust of the soil). The formulas and diagrams for simple beams given in a preceding section apply here and also in the case of column footings.

In column footings bars should be placed at right angles to each other and parallel to both axes of the footing (if footing is rectangular). It is sometimes advisable to place diagonal bars also if the footing is very large. The footing should be designed as a cantilever beam carrying a uniform load equal to the pressure on the soil under footing. The proper area of steel for each of the two sections (sections taken perpendicular to steel bars) should be taken at 0.0075 of the area of concrete above center of gravity of steel reinforcement. The thickness of the slab should vary uniformly from a maximum (determined by simple beam formulas or diagrams) immediately under the column to about one-half or one-third this thickness at the outer edges.

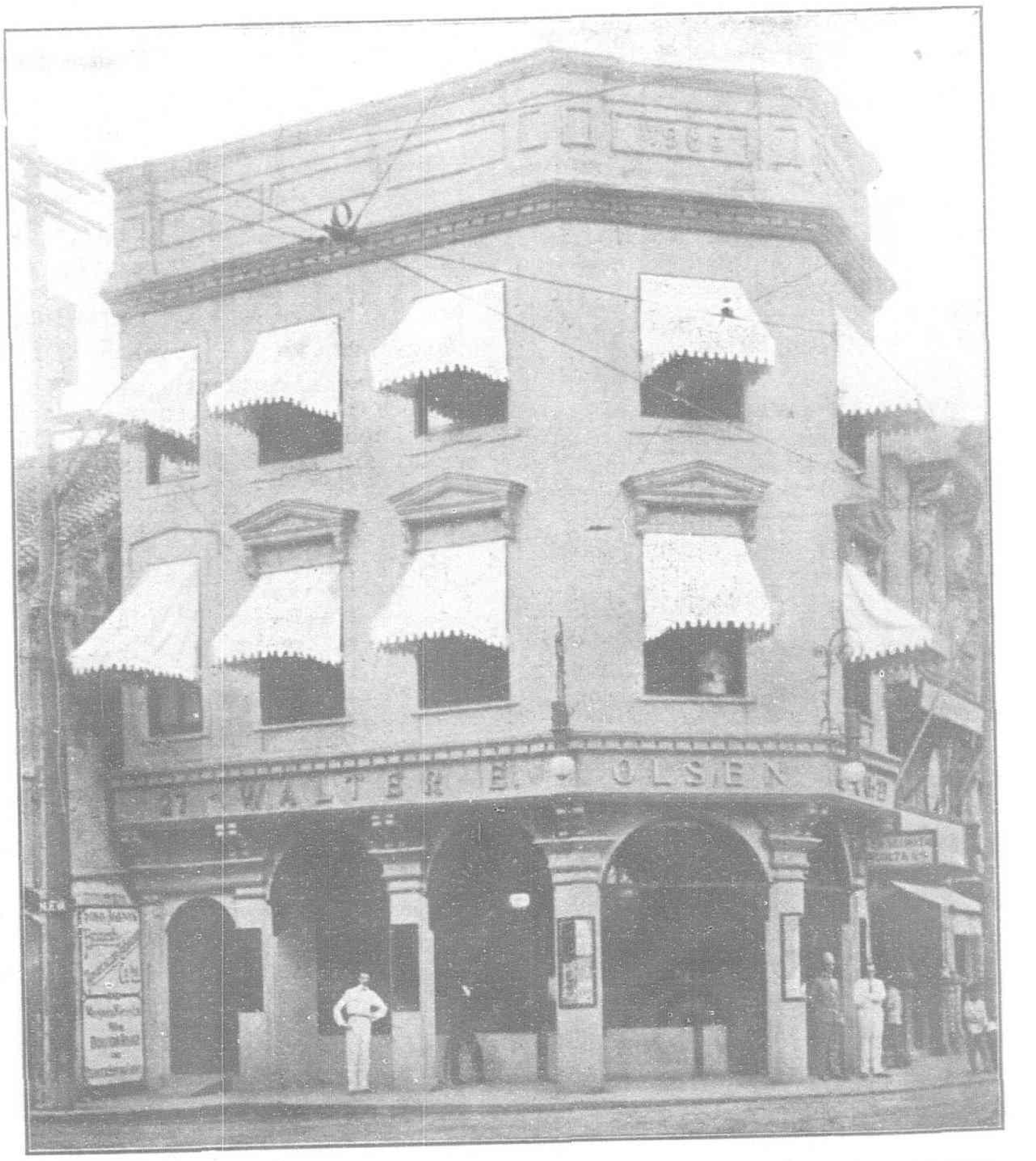
LONGITUDINAL SHEAR.—Cases may arise when the shear between the steel and concrete exceeds the safe working adhesive strength. To determine this we have the following formula from Prof. W. H. Burr's *Resistance of Materials.*

Let f_c = the stress in the concrete in the plane of the center of the reinforcing, at the distance h (*Fig.* 1) from the upper edge of the concrete.

I = moment of inertia of section.

p = perimeter of steel reinforcement.

k = intensity of shear on the surface between the steel and the concrete.



FRONT ELEVATION OF THE OLSEN BUILDING, ESCOLTA, MANILA; CONSTRUCTED OF REINFORCED CONCRETE BY THE MANILA CONSTRUCTION COMPANY

F = total transverse shear at the given section.

fs = the intensity of stress in the steel.

$$k = \frac{Es}{Ec} \div F.\ As\ .\ V \div I\ p. \qquad (9)$$

If k exceeds a value of 60 a mechanical bond must be secured between the steel and concrete. This may be effected by using Thacher, Kahn or twisted bars, or increasing the surface of the steel rods by substituting bars of smaller diameter, or by attaching stirrups vertically or inclined at 45° to the main bars. The form of stirrup advocated by the author is that of a U shape with hooks or loops at the ends. Placed in position the hooks or loops should engage the main bars in the lower part of the beam and be inclined toward the nearer support. The cross bar of the U should lie within an inch or so of the top of the beam. The spacing of these stirrups should be not greater than the depth of the beam. The diameters of U bars should not be less than one-half the diameter of main bars. No originality is claimed for this form of providing for longitudinal shear.

VERTICAL SHEAR.—This is one of the most unsatisfactory phases of reinforced concrete design. The great number of tests made give only conflicting evidence as to the manner in which beams should be designed to provide adequately for it.

If the vertical shear due to maximum safe load produces at any section a greater shearing stress than the safe working shearing stress (40-60 lbs. per sq. in.) longitudinal bars are introduced in the upper part of the beam and as far from the upper edge of the concrete as the main lower bars are from the lower edge of the concrete. In addition U bars, as described in the section under longitudinal shear, are so placed that the U bar acts as a mechanical tie between the upper and lower longitudinal bars. These upper longitudinal bars extend only over the portion of the beam where the safe working shearing stress is exceeded.

REINFORCEMENT.—The reinforcement should always be placed so that the distance from the center of gravity of the entire steel reinforcement to the upper edge of the concrete is not less than h. The distance from the centre of gravity of the steel to the lower edge of the concrete should never be less than two diameters of the bars used, and no portion of a steel bar should be nearer to the lower edge of concrete than 1½ diameters.

The spacing centre to centre of the steel bars should, if possible, not be greater than 8 diameters, nor less than 3 diameters.

FLOOR SLABS.—The calculations for the design of floor slabs will be identical with those for beams, a foot width of slab being treated as the unit.

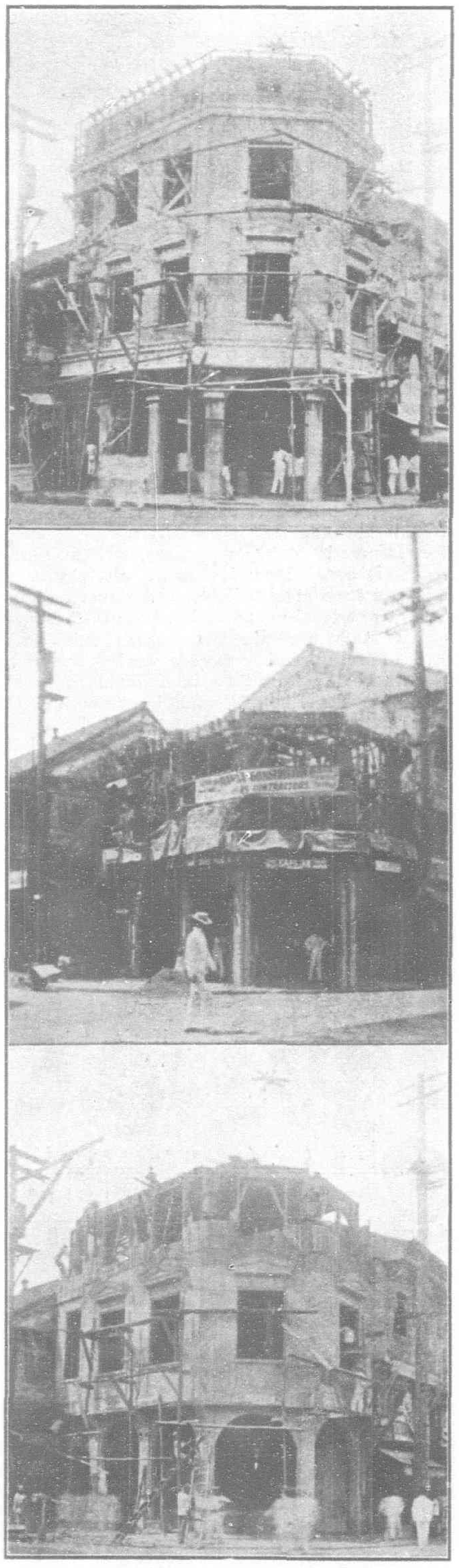
It does not often happen that longitudinal shear is so large in floor slabs as to require provision for it. In such cases the longitudinal shear might be provided for as in the case of beams. Usually a transverse steel reinforcement of one-third or one-fourth the area in the longitudinal section is more than sufficient to take up longitudinal shear, if the transverse bars are fastened, by wiring, to the longitudinal bars. A minimum depth of 4″ is used for slabs.

T-BEAMS.—In a floor system of reinforced concrete the floor slabs are usually supported by beams, also of reinforced concrete, which are made monolithic with the floor slabs so that the effective depth of the beams is equal to the thickness of the floor slab plus the depth of the beam below the slab.

In addition to this, the concrete in the slab acts as an upper flange of the beam forming a T section.

There is no standard practice in the design of such sections and few tests have been made that would indicate how much of the slab really acts as a compression flange of the T beams. The tests demonstrate clearly that a T section is much stronger than a rectangular section whose total depth is the same and whose width is that of the lower part of the T section.

Referring to *Fig.* 2, which is a typical T-beam section the whole construction being monolithic, the writer proposes a method which is believed to be conservative and give results that are safe. The method proposed is amply safe, as compared with other methods which assume that the slab acts as an upper compression flange for a distance both ways from the center of the beam equal to ½ l, and that this whole flange area is in compression.



OLSEN BUILDING IN COURSE OF CONSTRUCTION

In *Fig.* 2 b is the total width of the beam. Assume that the slab acts as a flange only for a distance of 1½ b from the center of the T section, making a total effective flange width of 3 b.

Let t = thickness of floor slab.

Then the area of concrete above the reinforcement is

$$b\ h + 2\ b\ t = Ac.$$

Substituting this value of Ac for the value b h in formula (8) we have

$$M = K\ h\ (bh + 2bt) \qquad (10)$$

Since the slab is always designed first, the value of t is known, and if b is taken as a fractional part of h the only unknown term wil be h.

Compute, as in any beam design, the maximum bending moment due to dead and live load, decide on the constants c, f, p and Es ÷ Ec and from the diagram take off a value of K corresponding to the constants assumed and treat as in the case of the simple beam for which the formulas have already been derived.

EXAMPLE.—Suppose t = 4″, b = 12″ and c = 300, f = 12,000, Es ÷ Ec = 7.5 and the total maximum bending moment is 50,000 foot-pounds. What depth of beam is necessary to carry the given load?

Assume a value for p of 0.015 which has been found a fairly economical one for this region and in the diagram the value of K is found to be about 59. Since in formula (9) the bending moment is expressed in inch-pounds we have

$$M = 600{,}000 = 59h\ [12h + 24\ (4)]$$
$$708h^2 + 5701h = 600{,}000$$

From which we have approximately.

$$h = 25.2''$$

For the value of d add twice the diameter of the reinforcing bars to the value of h just found. For shear, vertical and longitudinal, use the same treatment as for simple beams. Practically all that has been given in the design of simple beams will apply as well to T-beams.

RETAINING WALLS.—By treating the retaining wall as a beam subject to a transverse load often-times considerable economy may be found in using reinforced concrete in such construction. If in *Fig.* 3, A B C D be considered as a base monolithic with respect to E F G H and capable of resisting the bending moment at the section H E, exerted upon it by the pressure of the earth against E F G H, which acts as a cantilever, we may proceed to compute the bending moment at H E due to such pressure and eventually design the base so that it will not only take the bending moment safely, but also distribute the load on the foundation so that the safe bearing power of the soil will not be exceeded. Another point to be considered is that the weight of the earth in the verticals through E and D acts on the heel of the retaining wall thus balancing part of the pressure brought to bear upon the wall.

Let Py be the pressure of the earth acting at a height above the base of one-third the height of the wall. Let X be the height D I and w the weight of a cu. ft. of the earth backing. If the angle of repose is equal to that of the surface of the fill we have the well-known formula

$$Py = \frac{wX^2}{2} \cos \Phi.$$

Φ being the angle of repose of the earth. For a horizontal fill we have

$$Py = \frac{wX^2}{2} \qquad \frac{1 - \sin\ \Phi}{1\ \ \sin\ \Phi}$$

These formulas appear in a number of textbooks and no development of them is here attempted.

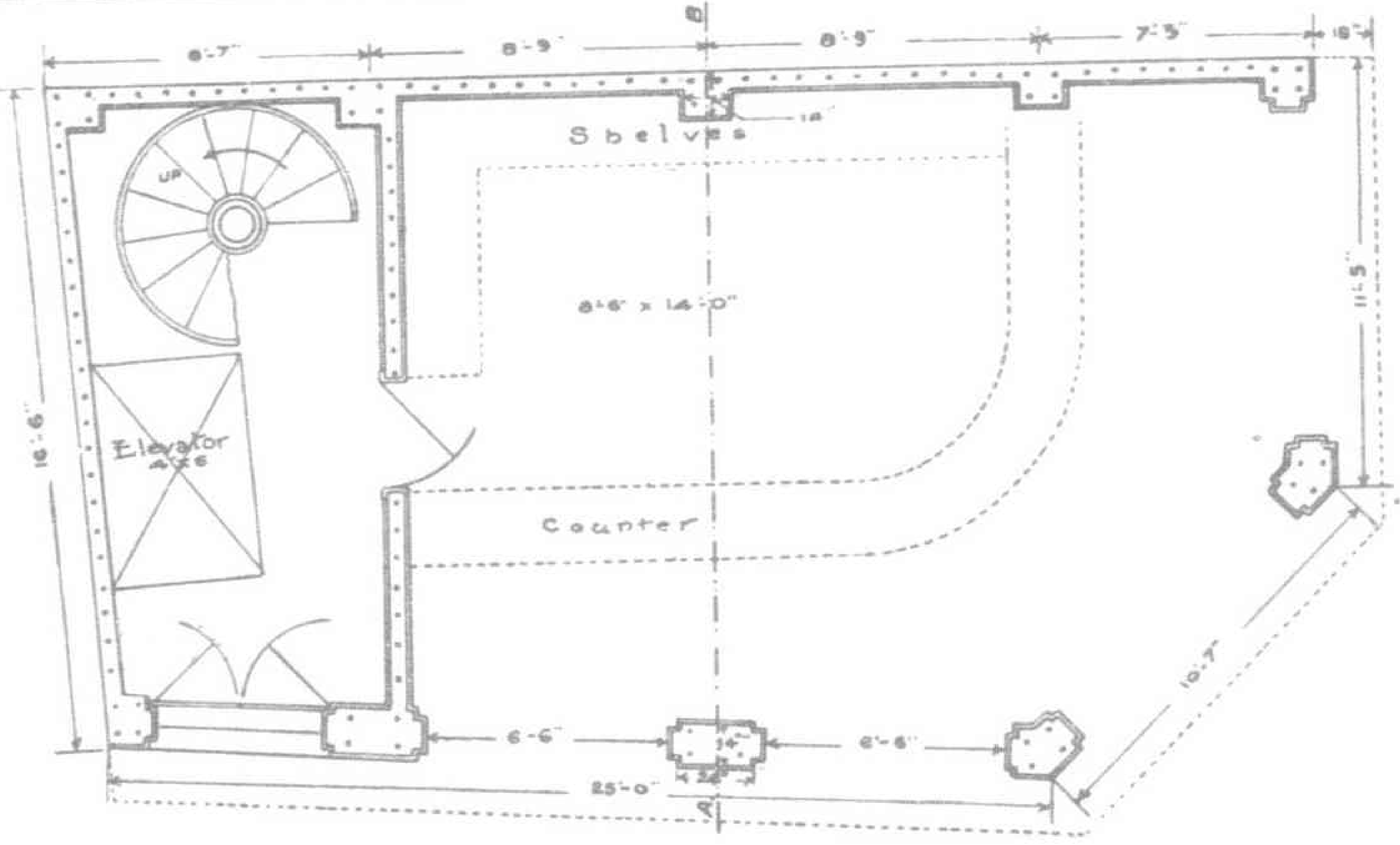
In any given problem assume the weight of the material to be placed behind the wall, and determine the natural slope of such material; 30° is a slope that will suit a great many cases and when at all doubtful even smaller values of Φ may be used.

From this data substitute values in the formulas just stated and determine the value of Py. Py acts at an angle to the vertical equal to ½(90°—Φ). It will be found most convenient to compute component P, the horizontal component of Py, graphically.

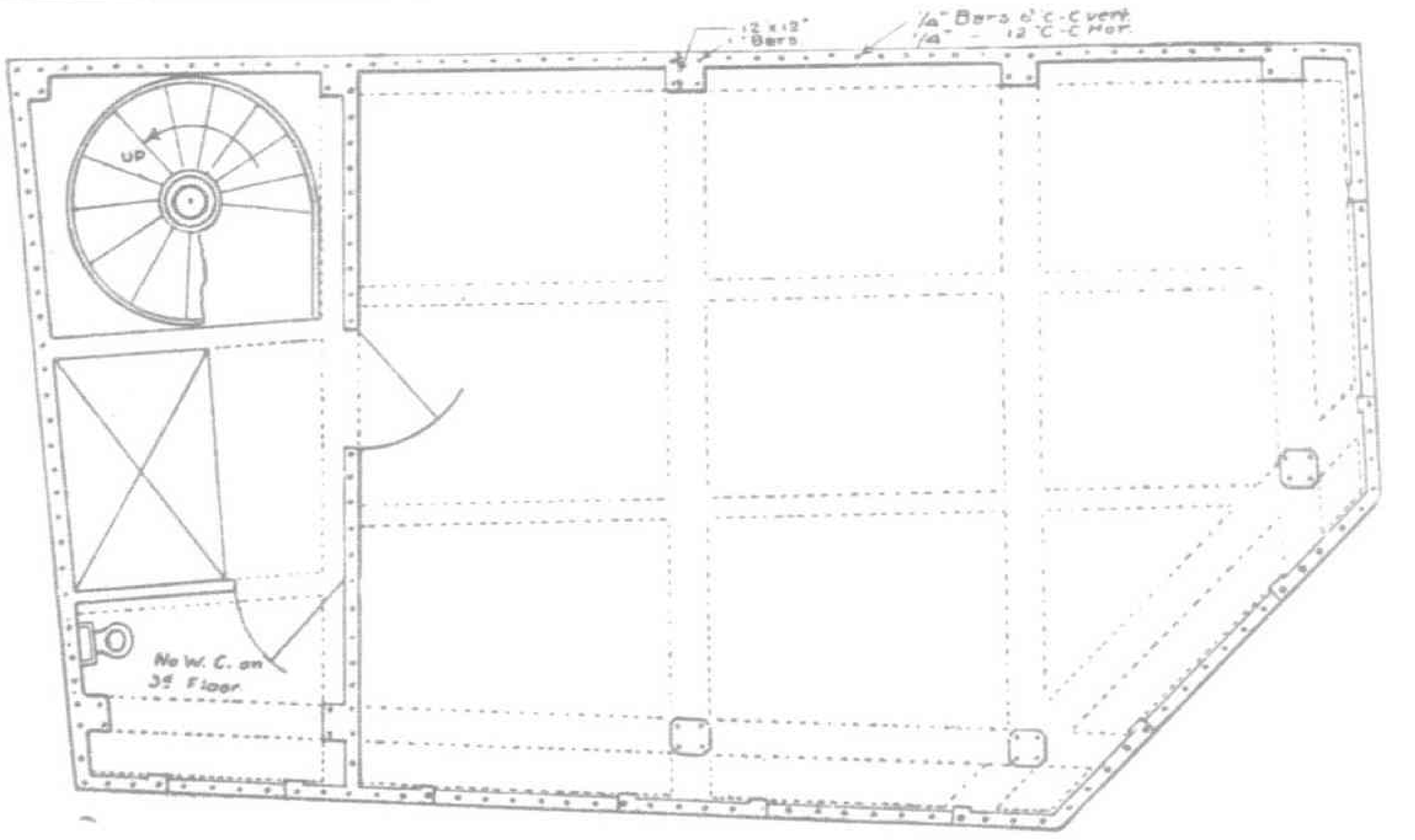
This found, the bending moment at section H E is obtained by multiplying P by $\frac{X}{3}$. The thickness of the base H E is determined as in the case of a simple beam. Then assume a base whose thickness is equal to H E and whose length, A D, is equal to one-half the height G I.

H should be at the middle of A D. Find the center of gravity of the section A B C D E F G. H combined with the prism of earth included between E F D I.

Pass a line O through the center of gravity thus found and find the resultant of the combined vertical pressure through O and the horizontal pressure P, plot the resultant and note its intersection with the base. It should pass within



FIRST FLOOR PLAN OF THE OLSEN BUILDING



SECOND AND THIRD FLOOR PLAN OF OLSEN BUILDING

the middle third, though if just outside the middle third, and the safe bearing power of the soil is not exceeded the design will be safe. If W′ is the vertical component of the resultant pressure, s is the distance from the center of gravity line and the point in which P M cuts the line B C, and r is the length B C, we have from mechanics, the maximum intensity of pressure on the base will be at the outer edge of the toe B equal to

$$p' = (W' \div r) + (W's \div \frac{r^2}{6})$$

and the minimum pressure will be at the point c and equal to

$$q = (W' \div r) - (W's \div \frac{r^2}{6})$$

If s is greater than $\frac{r}{6}$, q will be negative and the heel D C will have a tendency to rise.

If the ultimate bearing power of the soil under the toe, A B, is exceeded the heel will go up and the wall will fail.

The reinforcement in the base will be found as in a simple beam after the loads are finally determined. The reinforcement in the upper part of the base should be about one-half of that in the lower part. One important item must not be overlooked, longitudinal shearing strength of the inclined bars when they enter the base should be computed by the formula given under longitudinal shear. If the safe adhesive strength of the concrete and steel is exceeded, a mechanical bond should be provided. Also, the section H E should be thick enough to take the shear due to the horizontal pressure.

An improvement on this method of treatment is to design counterforts of sufficient strength to carry all the thrust due to the panel loads between them and to have thin slabs, of varying thickness with horizontal reinforcement, span the spaces between the counterforts.

A table is given for pressures and bending moments for computation of retaining walls.

Economical Design.—In regard to this subject, the writer has made a number of designs, mostly in bridgework, with a view to determining the limits in which certain types of construction should be used for greatest economy. A series of slab floors was designed with spans from 4 to 20′ by 1′ intervals, and from 22 to 30′ spans by 2′ increments designed for the same live loading, and also a series of arches with spans from 15 to 50′ by 5′ intervals. Assuming the cost of concrete in place at ₱20 per cu. yd. and the price of steel at 10 centavos per lb. in place, the following conclusions were drawn:—

The slab bridge (or floor) is economical for all spans up to 12′ clear. For a clear span greater than 12′ and up to 24′ the ribbed floor (T-beam type) proves most economical. The latter type for spans from 12 to 24′ will usually prove somewhat cheaper in first cost than the standard type steel stringer bridge in use by the Bureau of Public Works of the Philippine Islands at present. The costs assumed would not be strictly correct in actual practice on account of variations in the cost of forms, etc., for the different types, but they are a criterion to aid in chosing a suitable design for any given case.

For spans from 25′ and above, where it can be used, the arch is usually cheaper than the ribbed slab spans.

Reinforced concrete arches, when permanence is considered, are much cheaper in the long run than steel bridges, but sometimes they are not nearly so cheap as the latter. From estimates made covering spans from 30 to 50′ th- cost of reinforced concrete arches, with 14′ roadway, was found to be from ₱15 to ₱50 higher per ft. of span than steel superstructures for the same spans, the abutments being assumed to cost the same for either the arch or the steel superstructure.

REINFORCED CONCRETE CONSTRUCTION

[*Reviewing methods of design and construction, Reinforced concrete, 10th Engineering District.—Limitations and modifications necessitated by Philippine conditions of materia and labor.—Materials, formulas, tests, failure derived methods, and empirical formulas bas on ultimate strength of local materials.*]

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* The type of reinforced concrete bridge struc ture erected in this district has changed rapidl in recent years. The heavy arches originall constructed gave way in the last few years o the Spanish régime to steel spans. The firs years of the American occupation introduce standard Howe trusses and short stringer bridge of good design and poor material (2nd Grou of pine). Later the Supervisor's Office continue the use of the same types, but using good mate

TABLE OF CALCULATIONS OF PRESSURES ON RETAINING WALLS

Slopes Various—Heights Various—Earth at 90 Lbs. Per Cubic Foot—Fills Level With Top of Abutments.

$$\text{Horizontal pressure} = P = \frac{(wx^2)}{2} \frac{(1-\sin\Phi)}{1+\sin\Phi}$$

x = height of fill above natural soil

$$P = 45\left(\frac{1-\sin\Phi}{1+\sin\Phi}\right)x^2$$

[*This table to be used in special cases in designing retaining walls for 1 section.*]

Slopes Φ	1 on 6	15°	1 on 2	30°	2 on 3	1 on 1
Angle Φ	9°28′	15°	26°34′	30°	33°42′	45°
$\frac{1-\sin\Phi}{1+\sin\Phi}$	0.718	0.588	0.382	0.333	0.286	0.172
P. for x = 5 ft.	808	653	429	375	320	194
6	1162	958	624	593	463	281
7	1583	1290	850	791	633	380
8	2168	1650	1100	952	825	495
9	2610	2150	1388	1210	1037	626
10	3230	2660	1728	1500	1282	778
11	3910	3220	2100	1825	1558	942
12	4650	3830	2510	2178	1860	1117
13	5450	4470	2930	2600	2180	1360
14	6330	5190	3325	2950	2630	1514
15	7270	5950	3870	3370	2890	1740
16	8110	6650	4400	3830	3280	1980
17	9330	7700	4980	4330	3700	2290
18	10450	8620	5600	4870	4160	2530
19	11650	9620	6260	5450	4650	2820
20	12920	10640	6950	6000	5160	3110
Bending Moments foot-lbs. for	The B. Ms. are taken about the foot of vertical wall					
x = 5	1340	1185	723	630	535	325
6	2324	1916	1248	1186	926	562
7	3693	3010	1973	1832	1465	878
8	5760	4390	2890	2540	2190	1315
9	7830	6450	4164	3630	3111	1878
10	10760	7170	5460	5000	4273	2593
11	14400	11840	7740	6740	5750	3450
12	18600	15320	10040	8712	7440	4468
13	23800	19600	12680	11250	9470	5940
14	29700	24400	15700	15750	12250	7140
15	36350	28750	19350	16850	14450	8700
16	43000	35400	23200	20600	17550	10550
17	52200	43400	28400	24800	21200	12950
18	62700	51400	33500	29300	25100	15060
19	74400	61000	39600	34600	29700	17750
20	86400	71200	46000	39800	34500	20700

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* Paper read by O. D. Filley, 10th Engineering Dis trict of the Philippines, at the Annual Assembly o District Engineers in Manila.

rial (1st Group timber) and more recently have been introduced concrete designs embodying economies made possible by the practical application of the elastic theory.

The above first-mentioned type of bridge—the heavy arch of the Spaniards—was built of poor material (soft limestone). In removing these old structures, at the location of new bridges, this masonry has easily been handled with pick, bar or shovel. The design and execution of the foundations has been found to be uniformly bad,—in wasting material in their proportion and in a shallowness or lack of depth; a fault which has wrecked most of these structures. The ruins of 14 have been removed and replaced during the last few months.

The steel spans erected by the Spaniards are of French make—in one case on screw piles. These spans are still serviceable, but greatly weakened by rusting and by the burning of the floors during the insurrection. These steel spans were costly, light and short-lived.

The bridges erected during the American military occupation, although of good design, have gone the way of all timber bridges not of the 1st Group, preserved or roofed. The same type, using 1st Group, Molave, Ipil, or preserved timber, erected by the Supervisor's Office, will last from 5 to 10 years, with proper maintenance. These bridges, with abutments average ₱39 per running foot, and represent the best that can be done in this section in timber bridge construction.

Present Practice.—The radical change made possible in the design of curved and rectilineal arches by the application of the law of flexure, which allows the line of pressure to fall without the middle third and counteracts the resulting bending stresses with a definite reinforcing, permits the most graceful and permanent bridge-structure known; to compete, even in first cost, with the inexpressibly ugly truss, plate-girder and cantilever. The average cost of six arches between 25′ and 50′ over all is ₱37.38 per lineal foot.

Materials.—Gravel has been obtained from two sources, beach and river beds. The supply of beach gravel is practically unlimited, there being but few short stretches of beach where the sand is too poor in gravel to warrant screening. River gravel is obtained mixed with sand in about one-half the streams. Screening gives a gravel in appearance the same as beach gravel. The size is rather small, 9-10 passing through a 1″ ring. The beach gravel is slightly the harder, wearing better on the roads than the river gravel, but tests of concrete blocks, 4″ cubes, show no noticeable difference in the strength of concrete having these different gravels for matrix, though the average strength of this concrete falls somewhat below the strength of similar concrete assumed in the States' practice. The gravel is limestone and sandstone and apparently below the strength of standard gravel assumed by current tables, costing between ₱1 and ₱2 per cubic yard, delivered. Sand is of the same material, being the disintegrated gravel, and lacks in hardness, sharpness and size, and costs between ₱0.50 and ₱1 per cubic yard, delivered. No attempt is made to remove the salt from either the beach gravel or sand, and with no bad results further than the surface discoloration due to efflorescence. Fresh water is always obtainable.

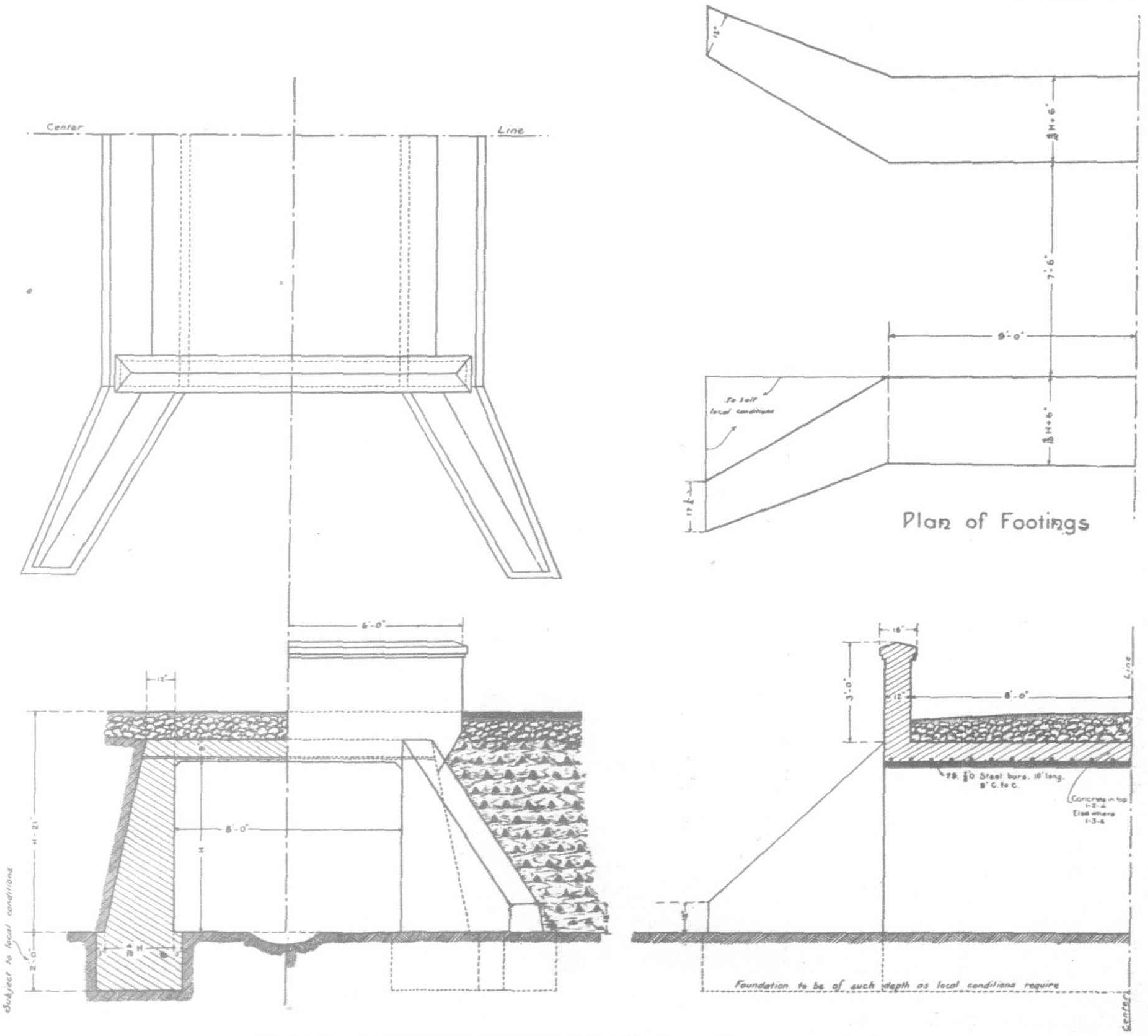
The cement used has been the *Green Island* Portland, Hongkong, which, since the detection of an occasional bad block of concrete, has been roughly tested when placed in arch-rings—each barrel being sampled. This cement has been obtained from local firms and from the Bureau of Supply, at ₱5.65, delivered in Iloilo.

Soft steel and wrought-iron have been used in sections of 1″ and ½″. These, as well as hard steel, have practically the same coefficient of elasticity (from 29,000,000 to 32,000,000), and under the same intensity of stress give the same amount of elongation or stretch regardless of the amount of carbon or of the grade of iron or of the elastic limit. These different grades are used interchangeably and are not given a load over 15,000 lbs. per square inch in any case—this assuming that for any grade of iron or steel the microscopic cracks and checks appear in the surrounding concrete at this stress and assuming that the limit of safety and usefulness is reached when these checks appear.

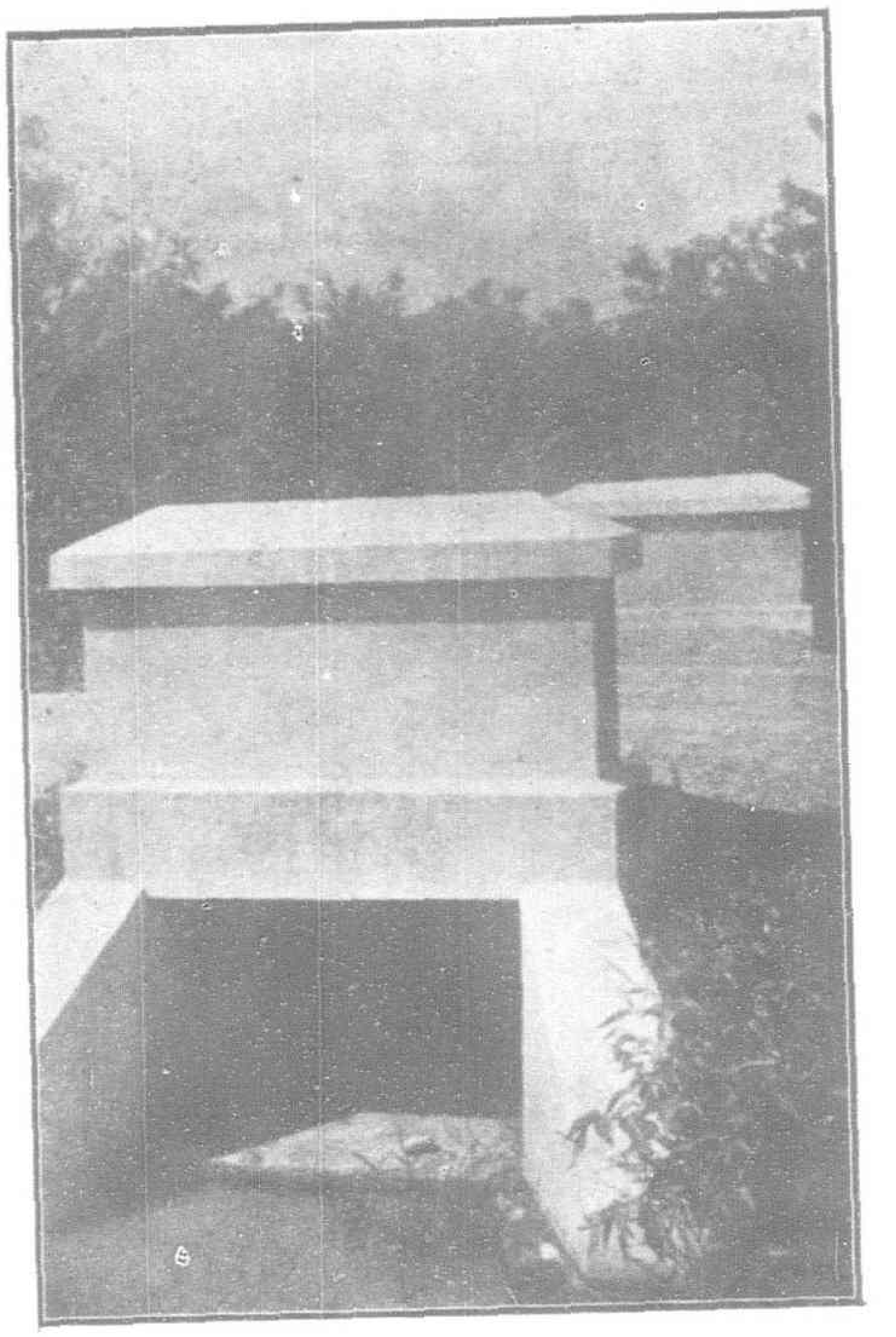
In respect to itself, hard steel gives a greater factor of safety. In respect to the composite beam, this extra strength cannot be utilized without wrecking the concrete, and, although for an equal moment of resistance, a beam will apparently absorb about twice the kinetic energy when reinforced by a high steel as when reinforced by wrought-iron or soft steel; yet the condition of the concrete about the reinforcement, which has been subjected to more than 15,000 lbs. to the square inch, is nothing more than cracked and permeable. Hard steel has no advantage over soft steel in reinforcing, and beams reinforced with any kind of reliable steel are given the same percentage of reinforcement, regardless of elastic limit.

No choice is given shape of section. Square bars give greater area of surface for equal volume, which is offset by the facility and completeness with which a round rod can be imbedded in the concrete. It has been suggested to place the square section diamond fashion or resting on one corner, but practically this requires more work than is warranted by the gain in facility of embedding.

Material for Forms.—Rough lumber, dressed umber, lumber lined with sheet-iron, and paper matting or Amacan on bamboo frame, empty cement barrels as centers for small culverts,


Center
Line
12″
3H+6′
7′-6″
9′-0″
To suit local conditions
3H+6″
12″
Plan of Footings
6′-0″
12″
H+2′
8′-0″
H
Subject to local conditions
2′-0″
16″
3′-0″
12″
8′-0″
Line
29. ⅝″⌀ Steel bars, 10′ long, 8″ C. to C.
Concrete in top 1-2-4 Elsewhere 1-3-6
Foundation to be of such depth as local conditions require
Center

STANDARD PHILIPPINE REINFORCED CONCRETE 8′ BOX CULVERT



STANDARD TYPE OF PHILIPPINE REINFORCED CONCRETE 3′ BOX CULVERT.

corrugated iron, machine-made collapsable steel forms for culvert pipes, and in reinforcing old timber bridges, the flooring in place, in steel bridges, the I-beams of the original structure are utilized as forms. Piling under foundation has been used from 6″ round to 18″ square, depending upon the conditions of load. The material has been considered unimportant, as piles are driven below water line.

Modified Formulas and Tables.—Foundations are run down to 4 or 6′, depending on material encountered and liability to wash. If at 6′ depth, good material for uniform bearing is not encountered, piling is resorted to. Bearing power, bottom of excavation: For safe loads for resistance on side of excavation for horizontal thrust of arches, take 8-10.

TABLE I.

Ordinary compressible wet sand of river bed	1½-2		tons sq. ft.
Alluvial soil—under spread footings	½-1		" " "
Gravel mixed with sand	4	6	" " "
Gravel and sand compacted, hardpan	8	10	" " "
Clay, soft in bed	1	2	" " "
Old Spanish masonry, poor	10		" " "
" " ", good	20		" " "
Native Limestone, beds soft	50		" " "
" " hard	100		

The hardened and compacted condition of the old road approaches can usually be utilized in providing the necessary resistance to the horizontal thrusts. Whether the main base of the foundation is horizontal, vertical or partly both horizontal and vertical, as is usually the case, or is inclined normal to the resultant of pressure, the resultant of pressure must fall well within and be properly distributed over these areas. Strength of resistance of unit sections of vertical face of excavations being taken as 8-10, the strength of the same material in horizontal plane or base.

Piles.—Assuming the pile is cut off below water line and that no brooming remains:—

Where L = Destructive load,
L′ = Safe load,
W = Weight of hammer, pounds,
D = Drop of hammer, last blow, in feet,
S = Set of pile under last blow, in inches:—

then $L = \sqrt[3]{\frac{D \times W \times 0.23}{S + 1.0}}$

Safe load L′ = ½ L to ⅙ L: take ½ L for firm material, and ⅙ L for river mud or marsh.

In estimating reloading old piles in good condition, well driven, when test loading cannot be effected:—

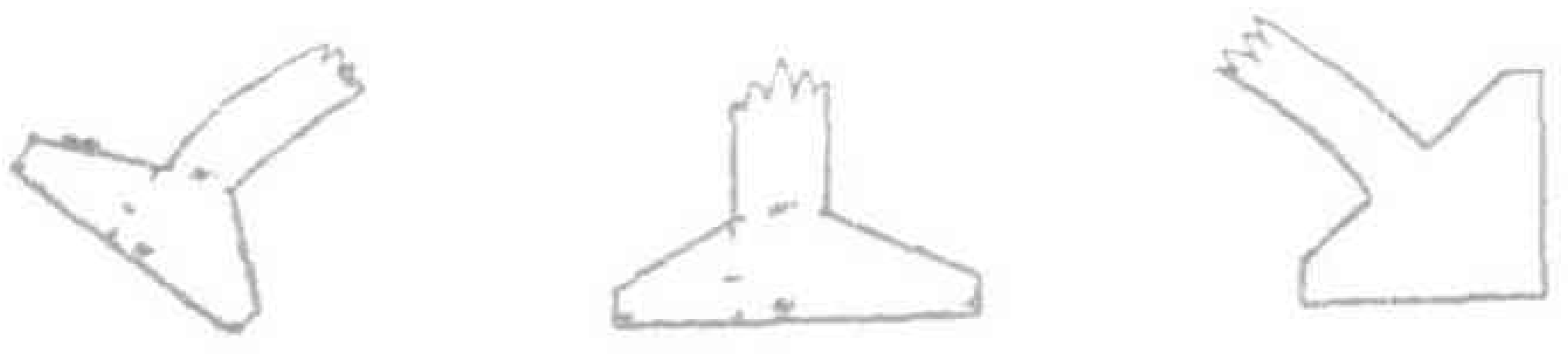
5—10 tons load below water line,

1—8 tons head of pile above ground, depending upon condition of pile and its bracing.

Posts, braces, short or well-braced false work: Apitong and 2nd group:—

TABLE II:

Diameter, inches.	Area.	Safeload, total tons.
1	0.8	0.3
2	3.1	1.3
3	7.1	2.9
4	12.6	5.2
5	19.6	8.2
6	28.3	12.
7	38.5	16.
8	50.3	21.
9	63.6	26.
10	78.5	32.
11	95.0	39.
12	113.1	47.
13	132.7	55.
14	153.9	64.
15	176.7	73.
16	201.1	84.
17	227.0	94.
18	254.5	106.



Spread footing in any position.

T = Thickness footing.
W = Width footing base.
W′ = Width footing top, superimposed masonry.
C = Distance C to C of bars.

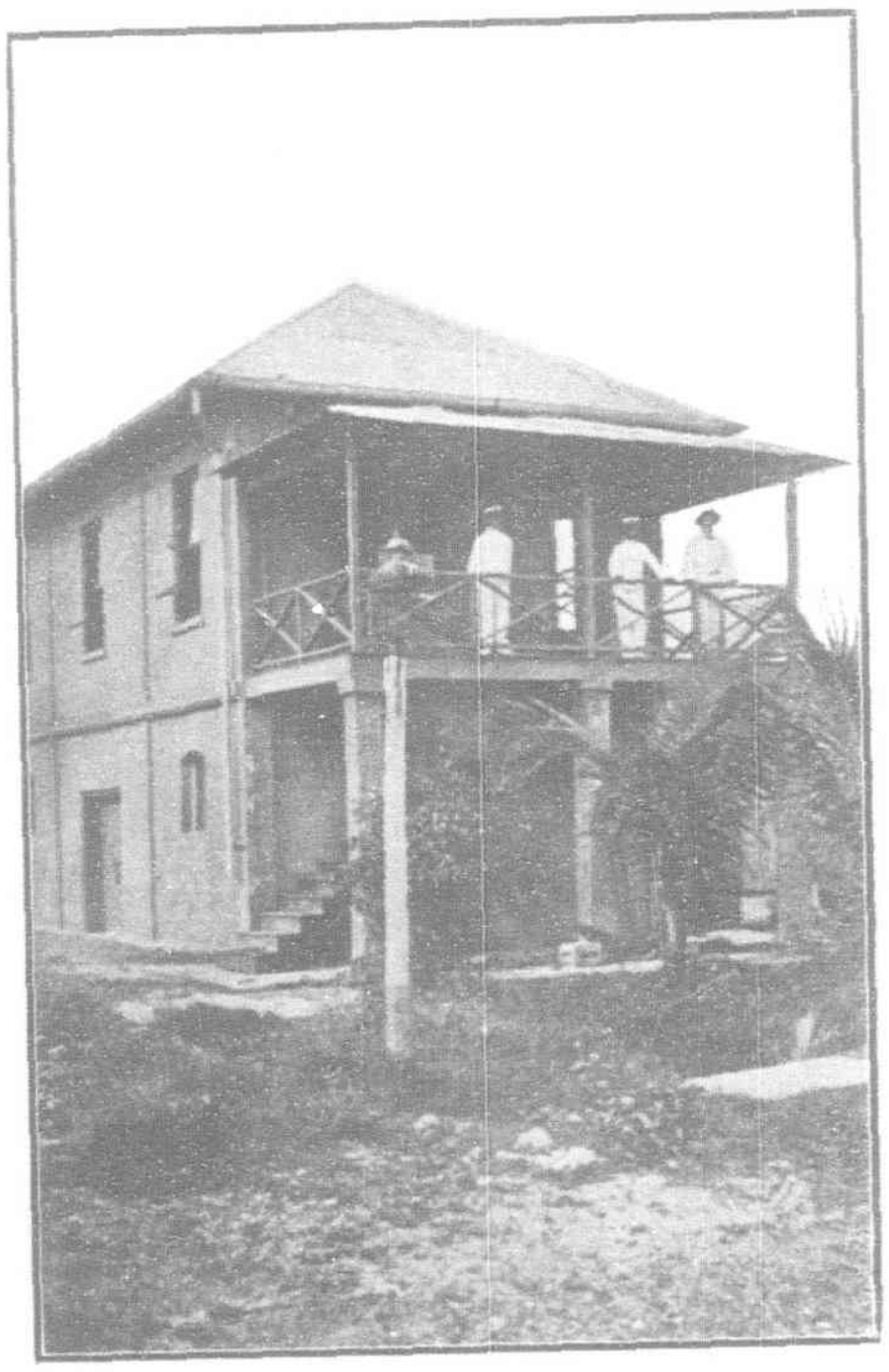
Assuming inch-square bars, tension 15,000 lbs. sq. in., 1:2:4 gravel concrete. Panay. Local conditions of labor and material. Table of dimensions of footing for 60-tons safe load, per lineal foot, perpendicular to reinforcing bars:—

TABLE III.

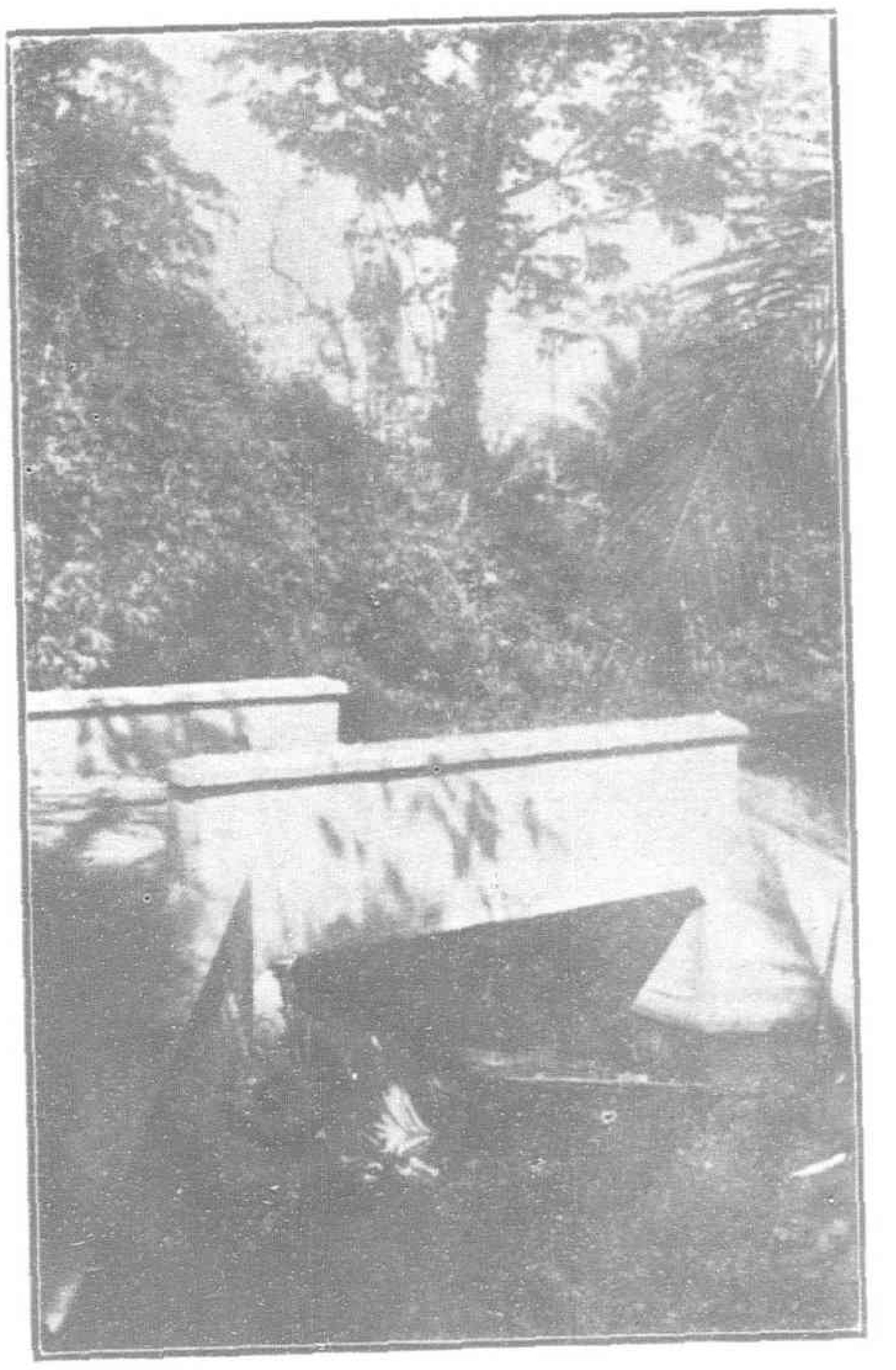
W	T	W′	C
18′	3′6″	6′10″	3″
17′	3′3″	5′6″	3″
16′	2′10″	5′0″	3″
14′	2′8″	4′8″	3″
12′	2′6″	4′4″	3″
10′	2′3″	4′0″	4″
8′	2′0″	4′0″	6″
6′	1′8″	3′6″	10″

or generally Mo = 0.85 d ST. (Sewall.)

Mo = Moment of resistance of cross sections.



REINFORCED CONCRETE OFFICE AND STORE-ROOM OF THE SURVEYOR OF THE PORT, AT ILOILO, COST ₱4,110



STANDARD TYPE OF PHILIPPINE REINFORCED CONCRETE 14′ CULVERT

d = Effective depth, *i. e.* depth to center of steel.
S = Area steel reinforcement.
T = Tensile stress per sq. in. metal.

Assuming balanced arch-thrusts, central piers are given a thickness of 1-12 clear span without reinforcing.

Abutments.—The abutments must be massive and designed to resist the overturning moments. This is usually easily effected with a proper adjustment of spread footings. The elastic theory is based on the assumption that the abutments are rigid and the large moment of inertia of massive design, large in comparison with the section of the arch ring is necessary, assuming elastic yielding of the abutments.

At the intersection of the abutment and arch ring, the angle between the resultant of the forces of the arch ring and the perpendicular to the bed of any layer of concrete should be maintained less than the angle of repose or 20°—30°.

Abutments for flat arches and their wing walls may be designed as simple retaining walls by b = 4/10 h which gives ample section for the vertical load of ½ weight of bridge.

High wing walls, spandrel walls and retaining walls:—

$$Py = \frac{wx^2}{2} \cos\theta \times \frac{\cos\theta - \sqrt{\cos^2\theta - \cos^2\phi}}{\cos\theta + \sqrt{\cos^2\theta - \cos^2\phi}}$$

Where Py = Resultant pressure.
W = Weight Unit volume backing.
X = Height of wall to top of fill.
ϕ = Angle of repose of backing fill.
θ = Angle of finished grade backing fill.

For level fill as is usually the case, $\cos\theta = 1$.

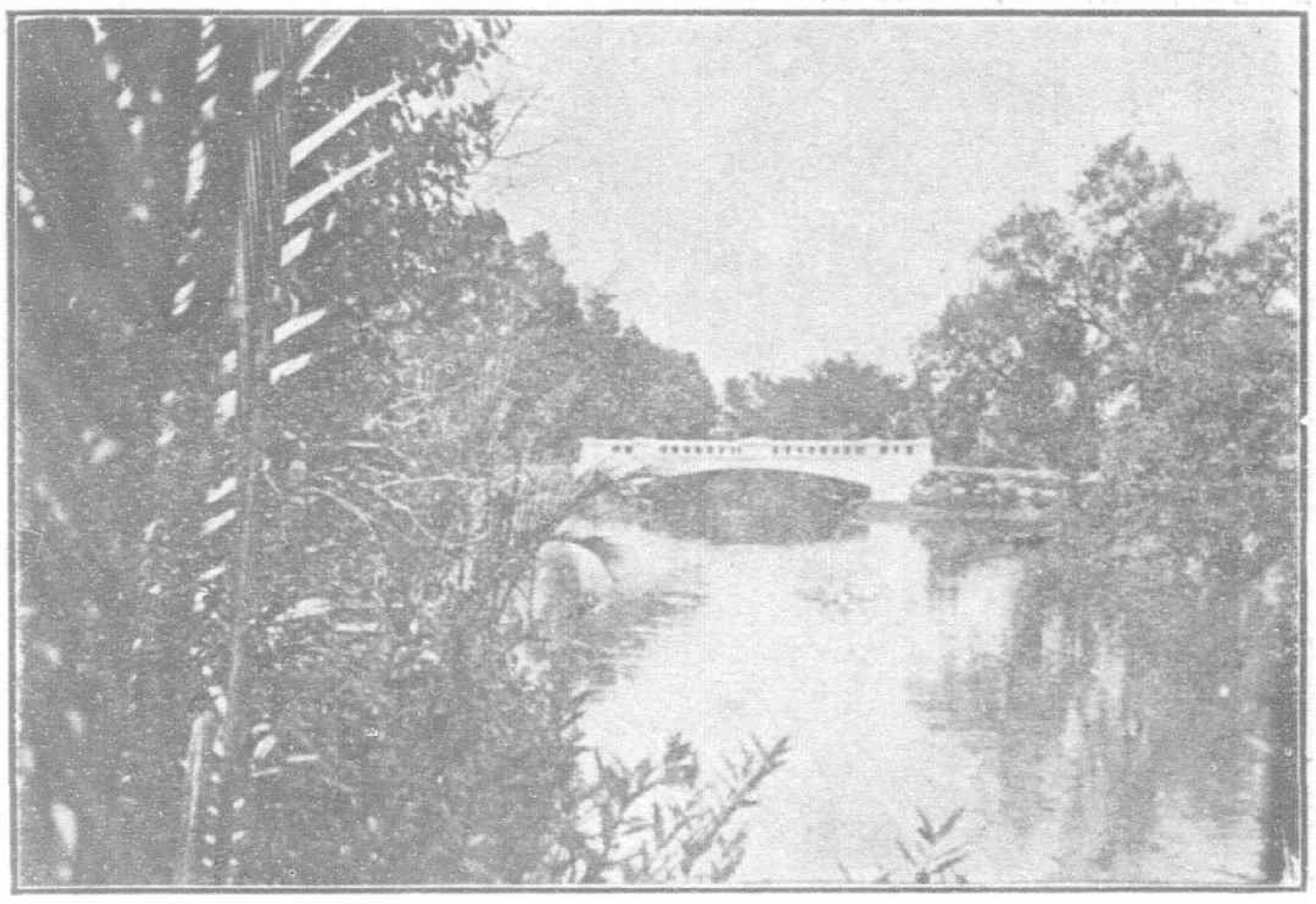
$$Py = \frac{wx^2}{2} \times \frac{1 - \sqrt{1 - \cos^2\phi}}{1 + \sqrt{1 - \cos^2\phi}} = \frac{wx^2}{2} \times \frac{1 - \sin\phi}{1 + \sin\phi}$$

Dry fill

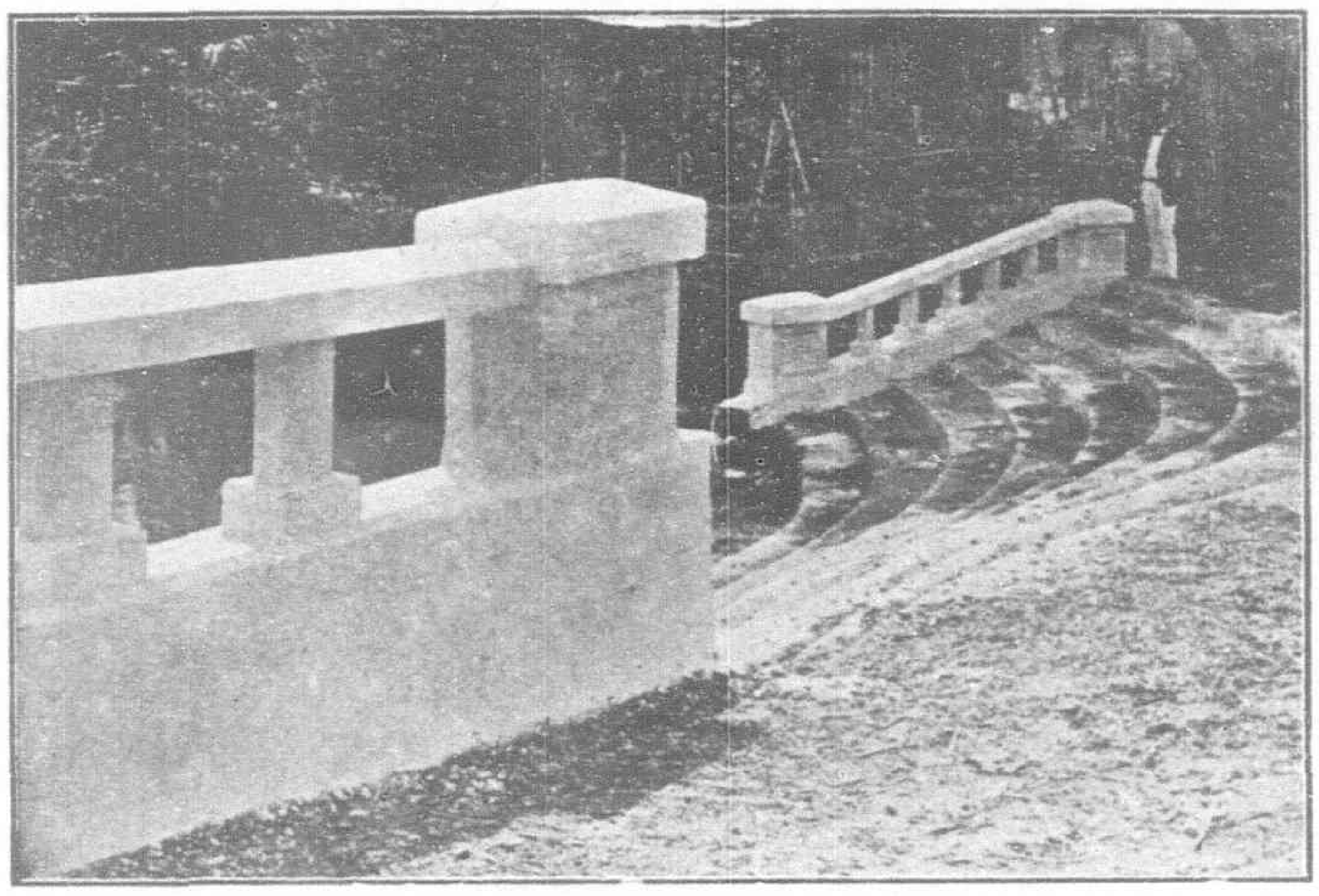
With $\phi = 1\frac{1}{2}$ to 1, slope $\phi = 33° 41′$ sin = 0.555 and $Py = wx^2\ 0.14$

In most cases, the backing is liable to become in part or wholly saturated with water during the rainy season through defective weep holes or drainage, and as the fill is usually made wet for compacting and to evade future settlement, $\phi = 0$ and $Py = \frac{wx2}{2}$ (a hydrostatic form).

Py acts at $\frac{x}{3}$ above base giving moment. Mo =



REINFORCED CONCRETE BRIDGE AT OTON, ILOILO PROVINCE; LENGTH OVER ALL, 50′; WIDTH, 16′; SPAN, 36′; COST, ₱1,374.21



RETAINING WALL AND WATERWAY STAIRWAY CONSTRUCTED OF REINFORCED CONCRETE IN ILOILO PROVINCE

$$\frac{PyX}{3} - \frac{wx^3}{6}$$

but Mo $=0.85$ d ST

$$S=\frac{Mo}{0.85\ ST} = \frac{wx^3}{5.10\ dT}$$ Giving area steel for assumed effective width of wall. (d =meas. face to steel)

or

$$d=\frac{Mo}{0.85\ ST} = \frac{wx^3}{5.10\ ST}$$ Giving effective width of wall for assumed area of steel. (d =face to steel).

The wet fill, as usually made, consists of surplus material from the excavation—sand, gravel and loam— which, when wet and rammed in layers back of arch and abutments, weights 120 lbs. per cubic foot =steel—T =15,000.

or Mo $=20\times^3$

$$S=\frac{.000158X^3}{d}$$

$$d=\frac{.000158X^3}{S}$$

Table of reinforcement and spacings, retaining walls on rigid bases as wing walls on spread footings, spandrel walls on arch ring, etc., assuming reinforcement locked into base:—

TABLE IV.

[12″ walls at base.]

Height "X"	Sq. in. metal for running-foot wall	Spacing C to C ½″ bars
4	0.019	13′
5	0.035	7′
6	.061	4′
7	.096	2′6
8	.143	1′7
9	.204	1′2
10	.280	0.9
11	.373	0.7
12	.484	0.5

[18″ wall at base.]

Height "X"	Sq. in. metal for running-foot wall	Spacing C to C 1″ sq. bars.
13	.615	3′2
14	.777	2′6
15	.945	2′0
16	1.147	1′6
17	1.376	1′4
18	1.633	1′2
19	1.921	1′0
20	2.240	0.8

Three points—crown point of *intrados* and two springing points of the same curve—are assumed in the following methods to be predetermined by the survey of the site. These points are determined as follows:—

Where

Q =Number of cubic feet per acre per second flow off through the bridge.

C =Coefficient varying from 31 to 75, depending upon the nature of the surface, 50 is assumed for prevailing condition in Panay Coast lands.

R =Average intensity of rainfall in cubic feet per acre per second, obtained from Weather Bureau monthly bulletin.

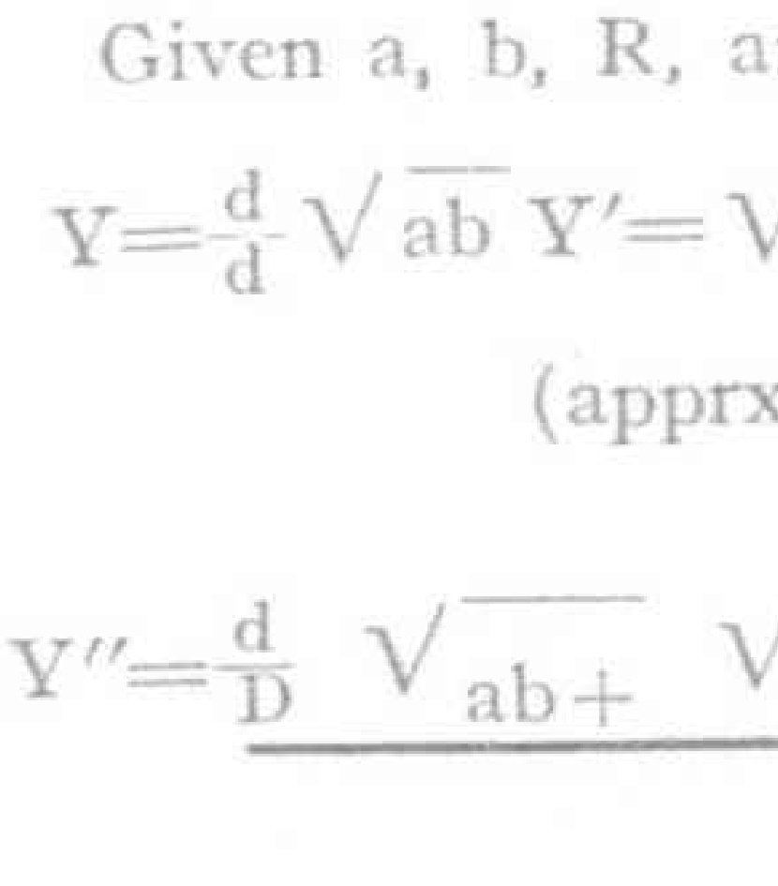
A =Area drained, in acres.

$$Q=\sqrt[4]{\frac{S}{A}} \qquad \text{(Hering)}$$

From the quantity of flowoff "Q," the profile of survey of site and the probable form of arch, the three required points are determinate, and are located on the profile. This assumed area of waterway is then checked by observing flood line on other bridge openings or restricted parts of stream and by taking the evidence of native inhabitants of repute, as to exceptional floods.

First Method.—Arch curves of Extrados and Intrados:—crown thickness—When earth loading is considered the curve of *intrados* is designed by passing the segment of a circle and the curve a semi-ellipse through three points in common—the crown point of the *intrados* and the two springing points of the same curve, and then bisecting the vertical ordinates between those two curves for the new intrados. This method has now been applied in several hundred concrete arches of spans up to 100′, all of which have proved so universally free from bending moments under earth loading that it may be accepted without further analysis of stresses. (Luten, *Engr. News*, LV. 13, 348).

Ordinates to intrados curve:—



S =Major axis ellipse.

d =Minor axis ellipse.

Y =Ordinate to point on ellipse.

Y′ =Ordinate to same point on ellipse.

a =Abscissa same from one vertex ellipse.

b =Abscissa from other vertex ellipse.

Y″ =Required mean ordinate $=\frac{Y'+Y'}{2}$

Given a, b, R, and S:—

$$Y=\frac{d}{d}\sqrt{ab}\quad Y'=\sqrt{R^2-(\tfrac{1}{2}S-a)^2}+\tfrac{1}{2}d-R$$

$$\left(\text{apprx } Y'=\frac{ab}{2R}\right.$$

$$Y''=\frac{\frac{d}{D}\sqrt{ab+}\quad\sqrt{R^2-\left(\frac{S}{2-a}-o\right)^2\frac{d}{x2}-R}}{2}$$

$$\text{or } \left(Y''=\frac{\frac{d}{D}\sqrt{ab}\quad+\quad\frac{ab}{2R}\text{ apprx.}}{2}\right)$$

The curve of *extrados* is then determined by the crown thickness and 1¼ to 1½ crown thickness at the quarter points.

Crown Thickness.—This determination is necessarily indirect, the dimensions being a function of the weight of the arch, which weight in turn is a function of this dimension. An approximate thickness is obtained from an expression combining the experience of past construction with theoretical requirements from which dimension is obtained the probable weights, the horizontal thrust and a graphic stress diagram.

The following expression varies as the bending moment and conforms with the principle that the moments very directly as the rise and gives a value for T which, although closely approximating recent successful examples of the States' practice, makes due allowance for the slight observed deficiency described in the concrete now being used:—

$$T=0.08\ R+0.008\ S.$$

Where T =Thickness of crown,

R =Rise.

S =Span.

Which gives the crown point of the curve of extrados. Two other points are determined by making the arch thickness at the quarter points 1¼ to 1½ crown thickness, a segmental arc through these points giving the required *extrados*.

The *intrados*, *extrados* and grade line of spandrel fill determines the dead load L from which is obtained the horizontal thrust H by

$$H=\frac{L\ S}{8\ R} \qquad \text{Where } \begin{array}{l} S\ \ \text{Span} \\ R=\text{Rise} \end{array}$$

The stress diagram and line of pressure are then determinate by graphics.

Dead Load.—From the stress diagram may be obtained the thrust amount and direction on each assumed voissure in any section of the arch ring, from which is deduced the arch thickness to resist direct thrust of dead load.

Live Load.—Maximum load is assured as acting upon the critical point 3/16 =span (Von Emperger) from center, moment of rupture Mo at point C is obtained directly by graphics:—

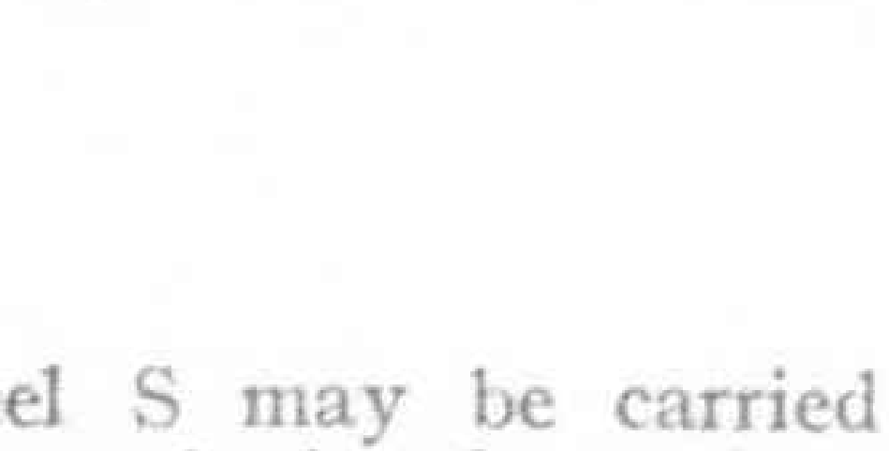
$$Mo=mn$$

and where $Mo=d\ S\ T$

$$S=\frac{mo}{d\ T}$$

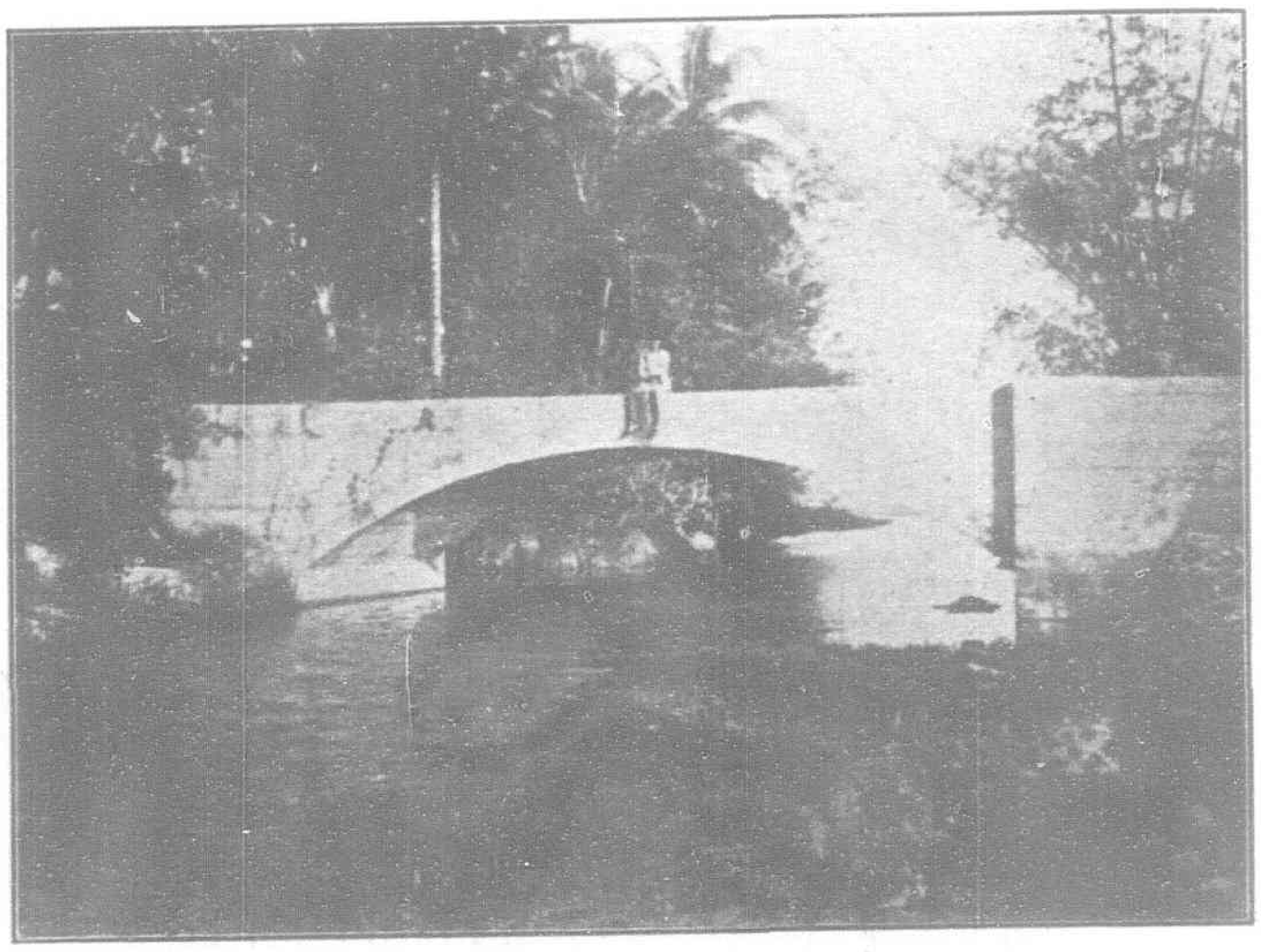
or $$S=\frac{m\ n}{d\ T}$$

where d=distance between centers of two opposed systems of reinforcing.



Which amount of steel S may be carried uniformly throughout the arch ring from abutment to abutment or varied proportional to Mo at different sections, retaining not less than 1 sq. in. metal to each sq. ft. in cross section. An equal amount S is placed at both extrados and intrados line, considering each system of rods as alternately a stiffened set of tension members and at a point opposite on the arch ring as a stiffened set of compression members no extra section of concrete is apportioned for the compressive resultant of bending moment.

STANDARD TYPE OF PHILIPPINE PROVINCIAL REINFORCED CONCRETE BRIDGE



PHILIPPINE PROVINCIAL REINFORCED CONCRETE BRIDGE; COST, ₱37.38 PER RUNNING FOOT IN PLACE

Mr. Cain gives good reason for "The radical depth of the reinforced concrete arch ring must not be made greater than is necessary for the maximum unit stress on the concrete to remain within certain safe limits." (Trans. Am. Soc. Vol XXXI—6—483.)

The advantages of this method are (*a*) the simplicity of the solution by graphics giving directly working dimensions and the fact (*b*) that there are no recorded failures where its provisions have been complied with.

The objections are (*a*) the empirical approximation only of the location of the line of intrados even though a second mean be taken between the derived intrados and the circular segment or the semi-ellipse: the attempt to fit a geometric curve to a curve which is theoretically and practically not geometric can only result in an approximation.

Second Method.—Application of the Law of Flexure in Solid Arches.—A refinement of the preceding method permits of an accuracy in the location and calculation of stress in the compression and tension members in respect to any possible location of the line of pressure sufficient to class the design of the arch among the determinate problems of structures.

From the data derived in the preceding approximate method corrected weights may be calculated, and a new stress diagram made. The final curves of intrados and extrados are located by taking equal depth of areas on either side of the line of pressure required by the direct pressure and bending moments derived from the stress diagram for live and dead loads as follows:—

Dead Loads.—The stress diagram gives the direct pressure normal to any section of arch ring, pressure due to dead load and for this compressive stress a depth of ring is calculated depending upon the strength of the concrete in use.

The line of pressure falling in the geometric center of this design, the arch is evidently safe for the dead load assumed. The bending moments introduced by the proposed live load are then taken entirely by the steel reinforcement.

Live Load.—Assuming a maximum live load, its corresponding line of pressure is plotted and its intercept on an ordinate from the neutral axis or original line of pressure multiplied by the new pressure gives the bending moment in this section. The amount of the intensity of tensile stress to be taken up by the proposed steel reinforcement and the intensity of the compressive stress corresponding to be taken up by the equal area of steel at opposite surface of arch ring is obtained from:—

$$Mo = T\,i$$

$$S = \frac{T\,i}{d\,T}$$

Where T = Amount of deflected thrust on section of arch ring.

i = Intercept of ordinate between neutral axis and deflected line of pressure.

Mo = Bending moment on section.

Otherwise:—

Assuming as before, the tension resultant of the bending moment carried by the steel but the compressive resultant taken by the concrete in arch ring—by law of flexure in solid arches.

Assuming steel symetrically placed about neutral axis:—

$$fs = \frac{e\ T}{Ac + ea} = \frac{6\,eh'\,M}{Ic + eIs}$$

Where fs = Intensity of stress in steel.

$e = \frac{E\,s}{E\,c} = 20$ (Thacher)

T = Thrust on section 1″ wide, pounds.

Ac = Area of section of concrete 1″ wide

a = Area of steel per inch width b, $= \frac{As}{b}$

h′ = Depth of steel in inches.

M = Bending moment section 1″ wide, foot pounds = T t.

Ic = Moment inertia concrete Ac about neutral axis of combination.

Is = Moment inertia steel about neutral axis of combination.

Compressive strength of opposite system of reinforcing is ignored and voissure depths are increased by amount proportional to fc.

Shear and Cross Reinforcing.—Are not susceptible to algebraic expression. The best results are obtained by (*a*) shear reinforcing across the arch-ring at points bisecting and trisecting the half-ring in quantities varying as the span rise. Varying between nothing for semi-circular arches and 1.4% for a flat arch approaching beam construction and (*b*) cross reinforcing, transverse reinforcing of .04% of longitudinal section of arch ring.

Lapover of Steel.—The amount of lapover in rods to obtain the efficiency of the continuous bar assumed and the length that a bar must be anchored in concrete in order to withstand the pull of the bar in tension. Assuming inch-square bars under 15,000 lbs. tension and safe working adhesion under local conditions of 80 lbs. square inch of surface:—

Required length $L \times 4 \times 80 = 15{,}000$

$$L = 47''$$

Lapovers are therefore specified at 4′.

Reinforcing; Disposition of the Metal.—Transverse bars of small diameter must be used in slabs. For deep girders requiring large quantities of steel, it is better to use small units in two or more rows, if necessary, than to concentrate the metal. For arches subject to both the compressive and bending stresses, the requirements appear to be different, for instance, the Austrian tests on arches gave much higher results for systems of heavy concentrations spaced 39″ C to C than for systems of rods spaced but a few inches apart.

Flat Arches, Slabs, Beams and Ribbed Slabs.—Flat arches and slabs are considered as a series of beams side by side with transverse reinforcement of 0.35%.

Beams:—

Where W = breaking load pounds uniformly distributed.

D = depth beams to center of reinforcement, inches.

L = clear span in feet.

b = breadth of beam.

With reinforcement at 1.4%

$$D = \sqrt{\frac{W\ L}{293\ b}}$$

This assmes that the local concrete 1:2:4 is equivalent in strength to 1:7 gravel concrete of Kidder's test.

Otherwise:—

Local conditions of

fs = 15,000 fc′ = 400

and 1 = Span

a = Area steel in tension per unit of width.

$$v = \frac{q}{1.5333}$$

$$x = q - v$$

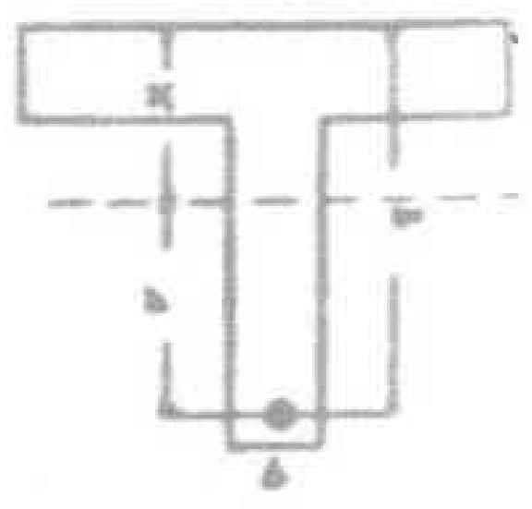
$$a = \frac{q}{144.38}$$

$$W = \frac{1666}{1}\left(\frac{x^3}{20\ v} + 3\,av\right)$$

Continuous Beams; Cantilever. That arches, slabs and beams built continuous over abutments with the upper reinforcing extending minimum distance of ¼ L both sides of abutment or equivalently anchored:—

$$D = \sqrt{\frac{0.8\ W\ L}{293\ b}}$$

Ribbed Slabs.—The rib and section of floor adjacent forms T-beam section.



The resistance of shear at plane of intersection of rib with floor is provided by the transverse reinforcement of floor and by increasing b of rib as it approaches intersection. The width of floor acting in compression as upper flange is limited by the strength of the smallest section of intersection of the beam and the slab, b being usually greater than t, the least section in greatest shear stress is that section of the slab falling in the v vertical planes of the faces of the beam.

$$\text{Shearing strength, safe. } S = \frac{f}{2\tan\theta} = \frac{400}{3.464}$$

= Apprx. 100 lbs. sq. inch.

The shearing strength on one side of the beam = $100 \times \frac{1}{2}\,tL$

The opposed strength of slab in compression = 400t × width of slab on one side of beam. Equating.

$100 \times \frac{1}{2}t \times L = 400t \times$ width of slab.

or Width of slab one side $= \frac{L}{8}$

The slab may therefore be assumed as acting as an upper flange to half distance to the adjacent parallel beam where this distance is equal to or less than $\frac{L}{8}$

The rib is designed as a beam carrying full load. The reinforcement of beam is then increased to 1.4% of area of concrete A+A′. Where A = area of concrete in beam and A′ area probably acting as flange, W is made $w \frac{A}{A+A'}$ and d recomputed. This assumes the value of the moment of resistance of the elements of the added slab area vary as the moment of the vertical elements of the beam, or T-beams.

Earthquake Provisions.—*Engineering News* editorially proposes "earthquake construction" for structures in earthquake zones, suggesting that structures be built in such a way that they can resist the vibratory impulses of shocks to a certain degree:—"The experience had with thousands of structures in the California earthquake affords the certainty that in the matter of building it is not impossible or even difficult to accomplish this. It seems probable that bridges may, with little trouble, be rendered fairly resistant."—The manner not difficult is, unfortunately, left undescribed. Analysis of possible stress produced by this cause appears impracticable. However, a provision may be supplied by an application of the fact that it is possible to assume such a combination of strains set up in the arch ring by earthquakes to produce their resulting maximum stress at any point in the arch ring; from which it appears that no part of the arch ring should be found weaker than another.

The variable amount of reinforcement provided by the preceding methods might be supplanted by a system of reinforcement of uniform strength throughout the length of ring and equal in section to the section required by the maximum bending moment of the live load.

False work.—For spans up to 30′, which includes the large majority of cases, the simple wooden curve rib without timber counterbracing is used in four lines for width of forms up to 16′. The small forces of possible derangement are taken care of by light bracing of such convenient material as bamboo, planks or scantlings.

The curved ribs for spans over 30′ are supported by posts and diagonal bracing proportioned by Table II.

The straight ribs or beams for flat arches and slabs:—

Deflection $D = \frac{5 \text{ W } l^3}{384 \text{ El}}$

Where W = Weight of pounds uniformly distributed.

l = Length of span, C to C of supports in inches.

E = Coefficient or modulus of elasticity of the timber.

E = 1,200,000 Apitong, Lauan.
1,600,000 Molave, Ipil.

I = Moment of inertia of cross section in inches.

Beams, single load middle:—

$L = \text{Safe load pounds} = \frac{b \text{ } d^2 \text{ } A}{S} \text{ or } b = \frac{S \text{ } L}{d^2 A}$

A from table.

$L = \text{Safe distributed load} = \frac{2bd^2 \text{ } A}{S} \text{ or } b = \frac{S \text{ } L}{2d^2 A}$

Beam, concentrated load not at center:—

$L = \frac{b^2 \text{ } d \text{ } S \text{ } A}{4 \text{ } m \text{ } n} \quad ab = \frac{4 \text{ } L \text{ } m \text{ } n}{d^2 \text{ } A}$

m and n distances of load from points of support.

Beam loaded two points m distance from each end:—

$\text{Each load } L = \frac{b \text{ } d^2 \text{ } A}{4 \text{ } m} \text{ or } b = \frac{4 \text{ } L \text{ } m \text{ } n}{d^2 \text{ } A}$

Values of A, coefficient for beams:—

Apitong	60	steel	888
Lauan	50	wrought-iron	666
Ipil, Molave	100	cast-iron	308
Dungan, Guilo		concrete	10
Redwood	60	limestone	14
White pine			
Yellow pine	100		
Oak	75		

Constants; steel:—

Soft, 0.15% carbon, ultimate tensile strength 60,000

Elastic limit 36,000

Modulus of elasticity Es 29,000,000 lbs. per sq. in.

Elongation 1 part in 14,500, 1 ton per sq. in.

Working stress 15,000 lbs. sq. in.

Concrete (local) compressive strength:—.

Ultimate compressive strength 1:2:4 7800 lbs. sq. in.

Ultimate compressive strength 1:3:6 4200 sq. in.

Safe $\frac{7800}{20} = 390$ take 400 lbs. sq. in.

$$Ec = 2,400,000$$

Tensile strength:—

$\text{Safe load } \frac{400}{10} = 40$ lbs. per sq. in.

Shearing Strength:—

$\text{Safe load } S = \frac{fc}{2 \tan \Theta} = \frac{400}{3.464} = \text{apprx. } 100$ lbs. sq. in.

Weight 1 cu. ft. = 135 lbs.

Tests and Derived Methods.—Systematic tests have been recently undertaken. Machine used: Steven's (Glasgow) hydraulic press, gauge reading to 1200 tons; Taller Visayas, Iloilo. Concrete cast in brass forms forming 4″ cubes, mixtures No. 1 and No. 2, age from 1 to 25 days.

Data derived was plotted graphically and the resulting curve until confirmed by future tests was prolonged by Trautwine's ratio to 6 months; ultimate strength is assumed to be double the strength at 6 months (Buel and Hill). The safe working stresses are obtained by dividing these ultimate strengths by the required factors of safety.

To test the practical limits of the assumed constants, derived from the small tests, it was decided to overload one of three spans under construction. Overloading may be accomplished by either increasing the load without changing the strength of arch ring, or by decreasing the strength of arch ring without changing the loading. The latter method was adopted and falsework and centers were slacked away from a 32′ span, 5′ rise, in 24 hours after placing the concrete. With the assumed constants, the 1:3:6 concrete of this ring had a breaking strength of 26 lbs. per square inch. The ring weighed 76,169 lbs., with a thrust in ring of 60,800 lbs. or 26 lbs. per square inch. The arch showed no signs of distress; a normal settlement of $\frac{3}{8}$″. Assuming the arch about to fail, the factor of safety of at least 20 was in evidence.

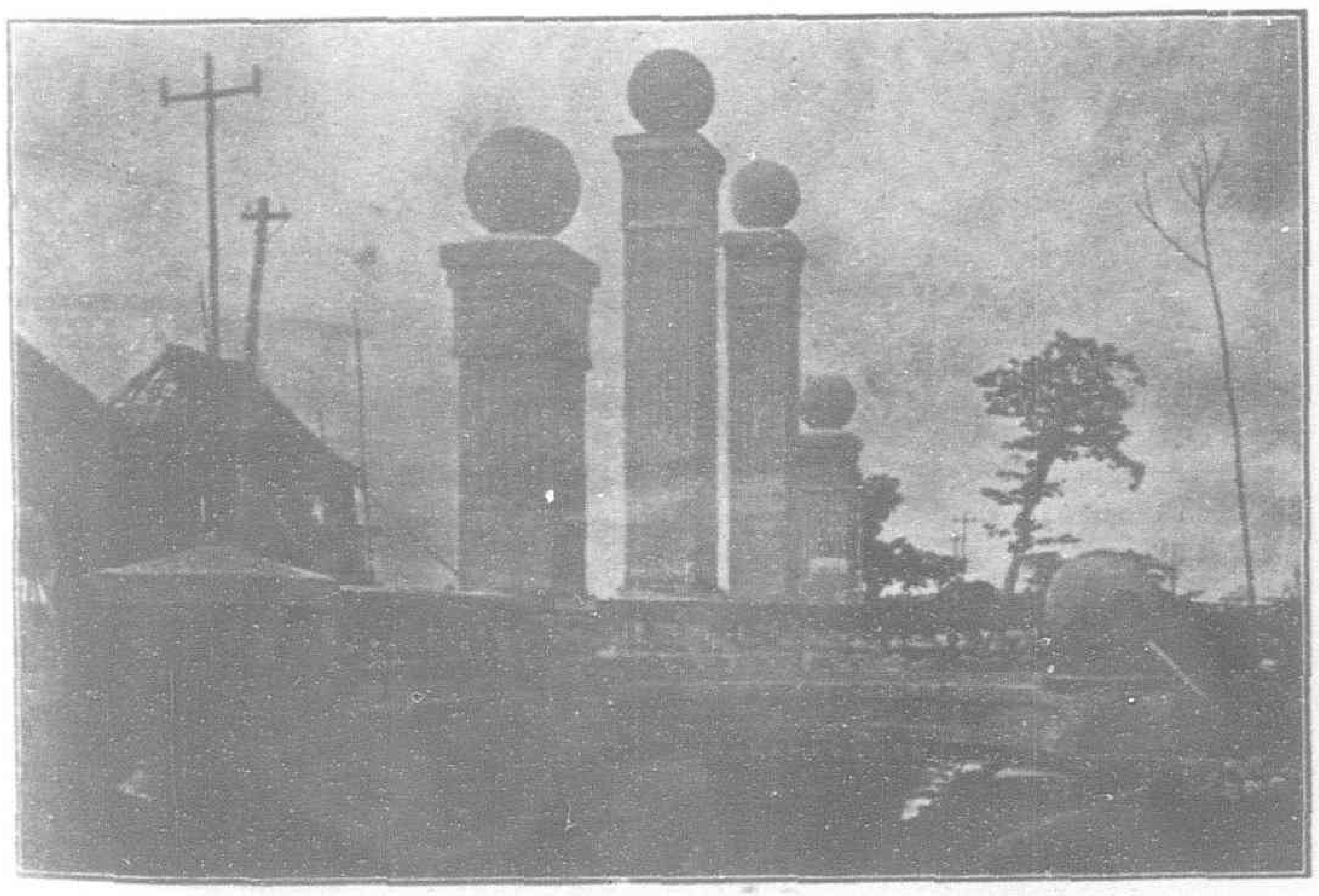
Assuming undue deflection as failure, a 36′ span, 3′ rise, was loaded to failure; mixture was taken 1:3:6. The arch was partly loaded with wet spandrel fill and centers removed at 7 days giving 140 lbs. thrust in arch ring, the calculated ultimate strength being 125 pounds. No vertical reinforcing between spandrel walls and arch ring. Arch and spandrels settled $\frac{7}{8}$″ during first day, $\frac{3}{8}$″ second day, arch ring separating from spandrel wall on one face, from spring line to 3′ beyond crown, spandrel wall on opposite side cracking vertically over spring line from coping to within 1′ of arch ring, crossing the horizontal reinforcing of 1 inch round steel.

Settlement ceasing, the arch was made stable by the reduction of the span to 34′ by filling in an offset in the foundations and by the conjugate pressure of the spandrel fill rolled down with a steam roller.

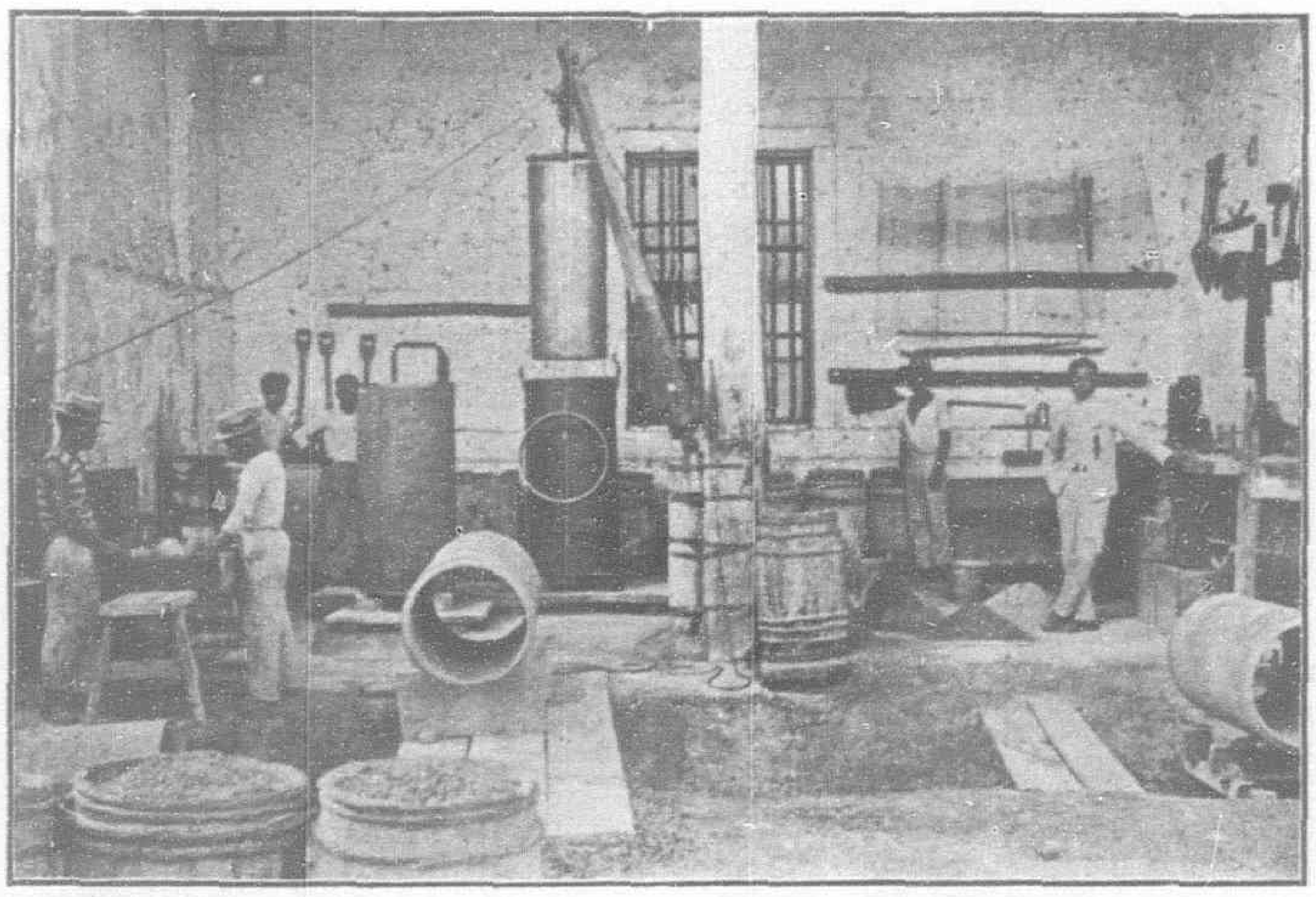
It would appear, in this case, (*a*) that the actual ultimate strength was not more than 140 lbs. or not more than 12% over the calculated stress; (*b*) that spandrel walls are self-supporting, and their weight should not be included in assumed load where artificial joints are not placed over spring lines; (*c*) that where settlement is expected, for reasons of light construction, yielding foundations or long span, that artificial vertical "expansion joints" should be left over the spring lines; (*d*) that the vertical reinforcing of the spandrel walls should be locked into the arch ring; (*e*) and that the wrecking of a reinforced arch by overloading is a slow process, with ample warning.

A flat arch, 9′ span, slab 6″ thick, 1:2:4, was tested after seven days, with concentrated center load of 3-ton roller, gave no measurable deflection. This is approximately equivalent to 12-ton center load (including weight of slab) at one end of each month, by form, ultimate strength W = 15 tons, center concentrated load.

Forms have been made for tests of T-beams, fish-belly and open truss construction in the attempt to procure a long span design without the objection of the horizontal thrust of the elastic arch, by which the adaptability of reinforced concrete construction would be extended



REINFORCED CONCRETE ENTRANCE GATEWAY AND CULVERT, SCHOOL OF ARTS AND TRADES, ILOILO



MAKING LIGHT REINFORCED CONCRETE CULVERT PIPES FOR THE PHILIPPINE GOVERNMENT; COST ₱3.20 EACH to any location where the light spread footing may be constructed. The satisfactory fish-belly type leads the way to a form of open truss construction of some promise.

Methods.—The necessity of the bridge being determined, the survey of site indicates the type and size of structure. Arch ribs falsework are marked out full size on the work. Bridge reinforcing is effected over tops of piles when material between piles is compressible. Concrete is made to a "wet" mixture although the ratio of 12 to 11 is in favor of the dry concrete, the ease of depositing and the good contact with reinforcing obtained make the wet mixture preferable. Vertical reinforcing for the wing walls and high abutments, and first reinforcement for arch ring are bedded in the sub-foundation and aligned. Concrete work on arch ring is continued without stop until finished (a small night gang keeping the concrete line fresh), placing vertical reinforcing for spandrel walls. In arches under 30′ span, falsework has been removed in all cases within two weeks, without damage. Curved, in place of angular, wing walls add practically nothing to the cost and present a better appearance. The same may be said of the open balustrade. All walls or surfaces locking in or tending to retain water, as at springing points of arches, must be drained by proper openings.

In arches over 30′ span, the centers should be left in from 30 to 60 days and the wet spandrel fill should be made before removing centers.

CEMENT IN FAVOR IN INDIA

A great deal of cement is used in India in building operations. Portland cement is considered the best and is used for all particular work. It is used in laying brick walls in foundations, and wherever wood is used for structural purposes it is laid in cement whenever possible. Floors, moldings, cornices, and outside and inside trimmings are made of sand and cement. Wherever cement can be used to guard against vermin, especially white ants, it is freely used. Houses that have flat roofs are covered with brick dust and particles of brick mixed with cement and stamped down hard. Pitched roofs are covered with corrugated iron or tile and then solidly covered with cement and sand. These roofs last well and require little repair. Artificial stone is extensively manufactured and used in India for building purposes and for pavements and walks. Floors are laid in cement and made ornamental by embedding broken glass and china in figures in the body of the cement. The outsides of temples are made in the same way and are very attractive. Thus cement is in general use and always will be in India. The imports of cement as long ago as 1870 were valued at $50,342 gold, advancing in the fiscal year 1900 to 729,478 hundredweight, valued at $500,332, and in 1906 to 1,778,428 hundredweight, valued at $1,070,275. The imports of cement for the first four months of the present calendar year were 574,006 hundredweight, valued at $333,427. The supplies of cement for India come mainly from the United States, the United Kingdom, Belgium, and Germany. Inferior cement is not wanted, but the best cement is in good demand at good prices.

ENGINEERING COMPANY'S PROGRESS IN NORTH CHINA

Regarding the affairs of the Chinese Engineering and Mining Company, Ltd., at Chingwangtao, which seem to be progressing most favorably, there is, in addition to the completion of the extension of the breakwater to 2,300′ and the work of replacing the jarrah piles of the pier by iron joists, which is now completed, the construction of a second chord quay in progress and a new berth of 300′ long has been constructed for the use of the steamer *Kaiping*. In speaking of Chingwangtao at the annual meeting, the chairman of the directory said:—

"The depth of water alongside this new berth is 19′ at low water of ordinary winter and spring tides. The stone buildings, each 100′ long by 45′ wide, have been constructed to provide quarters for 600 coolies. A brick godown, 600′ long by 45′ wide, was also constructed for storing cargo for steamers, besides smaller godowns. It may be mentioned, as indicating the increasing importance of the port, that several influential firms have already established themselves there, and a village of 2,000 inhabitants has sprung up within the last two years to the north of our coal yard, close to the boundary of the company's land. We are advised that the facility with which steamers can now be loaded and discharged at our breakwater and pier will bear comparison with any port in the Far East, and is superior to most. Last winter was one of unusual difficulty for steamers coming to the port, owing to the exceptional severity of the frost and the absence of the wind required to break up the ice; but although the ice extended for a considerable distance from the pier, it was never sufficient to prevent the ships from getting through. Our general manager writes that he looks upon the prospects of Chingwangtao as very satisfactory, and is confident that within a very short time further considerable development in the value of the port, as well as in the trade of the port, will be seen. We told you at the last meeting that the important question before us was the increase of our output, and that was mainly a question of dealing with the water in the Tongshan and Linsi mines. From the commencement of our company it has been recognized that a large part of the mechanical installations of the collieries left much to be desired on the score of efficiency. One consequence of this has been an excessive consumption of fuel at the mines. Our pumping appliances, particularly, have been a source of trouble, requiring as they have done, frequent repair; and, while they have hitherto served our purpose, they are quite inadequate to the task which will be imposed on them in view of the large increase which we propose to make in the output, and the necessity of guarding against the possibility of an inundation of any portion of the mines. Reserves of coal are known to exist in the Tongshan mine, which hitherto could not be worked for fear of causing a flow of water with which our pumping installation would not be able to cope. The installations for lighting and ventilation are also defective and insufficient for our contemplated scale of operations. In order to deal with all these matters, after prolonged investigation, we adopted a scheme for the construction of electrical stations at each of the mines of Tongshan and Linsi, these stations to furnish the power necessary for the pumping and the various other underground and surface installations on such a scale as to provide for the increase in the near future of the present production of about 3,000 tons per day up to 5,000 tons per day or more. In the months of November and January last, contracts were entered into for the necessary plant, which has been in course of erection for some time past. The buildings for the power stations are nearly completed. The contracts require that the pumping plant at Tongshan shall be in operation by November 8th, 1906, and that at Linsi a month later. The remainder of the accessory installations are to be completed in February next. The power-station at Tongshan will be capable of developing 3,200 h. p. and that at Linsi 4,800 h. p. The pumps are calculated to deal with all the water that may be expected after the full extension of the scale of our operations, and to leave an ample margin. The electrical stations will also be able to supply, later on, the necessary power for electrical traction in the interior of the mines, and thus enable us to replace the present mule transport, which is defective and costly. They will also provide power for the winches for the inclined planes, the secondary pumps; in a word, for the whole of the installations underground and at the surface. At present everything points to the contractors completing the works within the specified time. In order to obtain the increase of production, of which I have just spoken, it is necessary to enlarge, to deepen, and to reequip a pit at present existing at Linsi. At this shaft we have decided to establish mechanical screening, so as to permit of the coal being cleaned and classified, and thus provide for the various demands of the market. The amount of capital expenditure involved in the works which I have referred to will, of course, be very large; but we are glad to say that our financial condition is such that we are in position to meet all requirements. Now as regards the results of the current year, so far as we have gone they are eminently satisfactory. There has been an increase in the output of about 90,000 tons and an increase in the proceeds of the sales of about $300,000. All our information tends to show that we may expect a continuance of this state of things during the remainder of the year and a corresponding increase of profit. In conclusion, I think we may safely say that our enterprise is to-day in a stronger and healthier condition than it has ever been. As you have already heard, there is now a much larger demand for our coal than we have hitherto been able to meet. The works which we have undertaken, and which are now nearing completion, will not only place us in a position to meet this demand, but should also enable us to diminish to some extent the cost of production, and with these facts before us we are justified in looking forward to a steady expansion in the profits of the company, and, consequently, in due time, to an increase in the dividends."

Referring to the Tongshan Cement Company the chairman stated that the assets were not included in the balance sheet, but that the company's position in regard to this was that they were creditors, and that the figure at which the debts stood on the books was one which was quite satisfactory to the company.

On the whole the report of the company is very encouraging, and the business in a very thriving condition. The shares of the company have advanced and have been sold at Tls. 10.60 in fairly large quantities. Most of the shares bought lately were to supply the London market.

RAILWAY BUILDING IN CHINA

Brief mention has already been made in these columns, from time to time, of the dangers from disease and the difficulties of various kinds confronting the builders of the railway that is to pass through the Namti Valley in China. Now comes a report covering this same subject, issued by the Imperial Chinese Customs authorities of Mengtse. Consul T. Haynes, of Nanking, has forwarded it to Washington with the observation that it would seem as if China has her hands full of evils not unlike those encountered upon the Isthmus of Panama. The report of the Imperial Customs authorities is as follows:—

"The construction of the railway between Laokai and Yunnanfu (the great enterprise to which all well-wishers of Yunnan look forward as one of the means of permitting this province to take her proper place in the markets of the world) has been perseveringly pushed forward in the face of great difficulties both climatic and economic. The vile climate of the Namti Valley has levied a heavy toll on those who have dared to open up its primeval jungles and gullies. The death rate among the coolies imported from various parts of the Empire and put to work in this dreaded valley, may, without exaggeration, be estimated at 5,000, or 70 per cent of the total number employed on that particular section of the line. The company has made praiseworthy efforts to counteract the evils of the climate in this valley. They have constructed a large number of suitable dwellings both for foreigners and natives, and have doubled the number of hospitals, placing as many as seven doctors on the first 150 kilometers from Hokou. Instead of attempting to carry on the work in the Namti Valley all the year through the work is suspended almost entirely during the summer rains and the coolies moved up to the works on the high and healthier plateau. This measure, while it economizes the life of that most important individual in the building of any railway, namely, the coolie, must considerably delay the completion of the line, and we must therefore wait till 1910 at least for that great desideratum—the linking up of Yuunanfu with Haiphong. The year under review marks an important epoch in the history of French railway enterprise in Indo-China. On Christmas day the first locomotive reached Laokai on the Tonking Yunnan border, and it is hoped that the coming spring will see the commencement of a through railway service between Haiphong and Laokai."

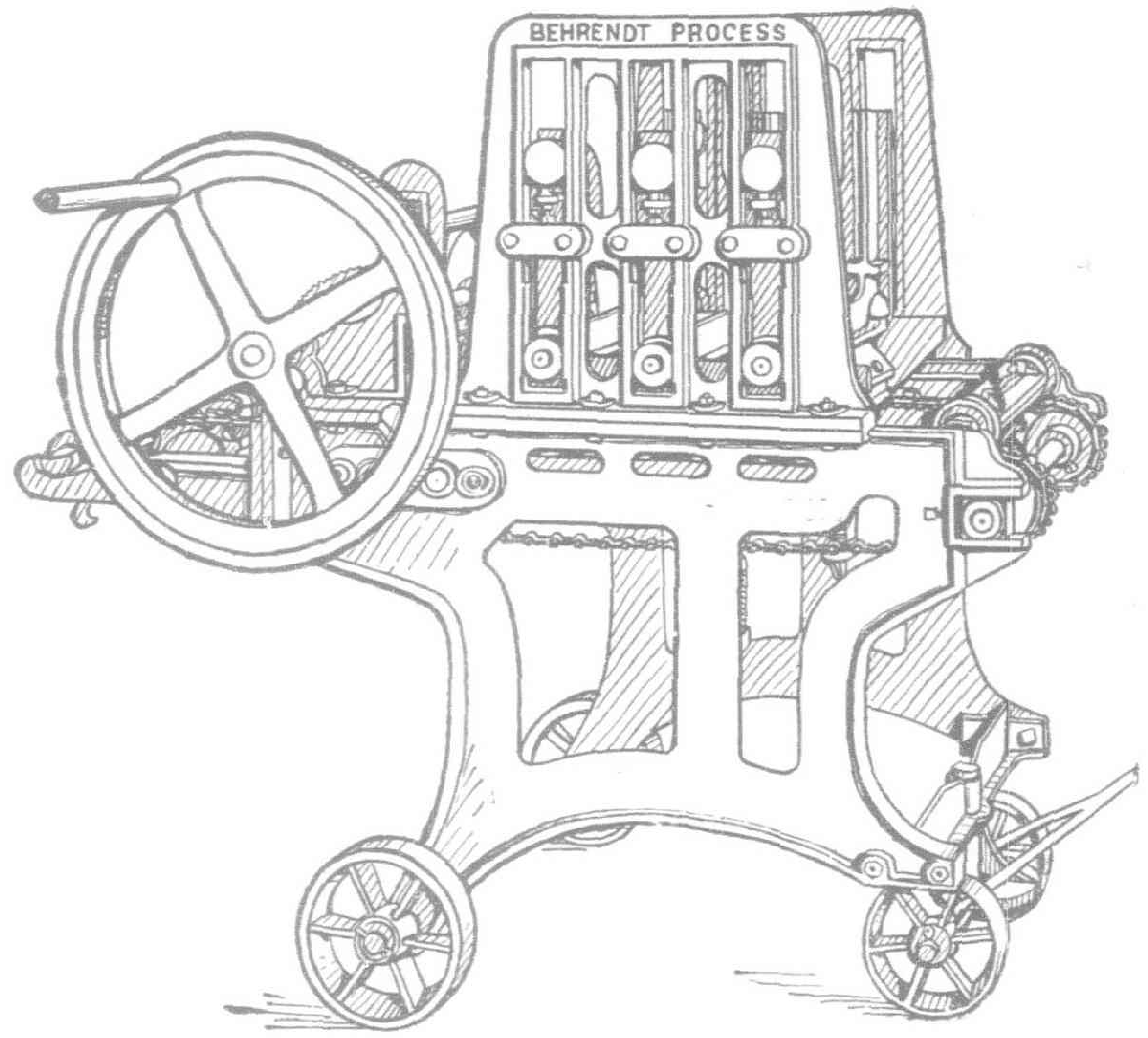
BEHRENDT FIBER-EXTRACTING AND CLEANING MACHINE

The Behrendt fiber-extracting and cleaning machine, known as the *Behrendt Process*, is so far the only one of the many hemp machines which are being perfected and experimented with by various inventors, that is now actually working in the field, and giving practical and profitable results. Six machines have been in daily operation for the last four months in the hemp-fields of the Province of Albay, Luzon, P. I., so whatever assertions are made in this brief exposition of the invention are based upon the practical results obtained in actual service and experience in the field.

The mechanism of the machine is very simple and can be handled by anyone, no technical knowledge being necessary. The machine can be worked either by hand or by steam, gasolene or petroleum power. Its capacity by hand is 50 lbs. of dry fiber per day; by other power 100 lbs. per day. One 2 h. p. gasolene or petroleum motor can run three machines, as each machine requires only ½ h. p.

The dimensions of the machine are as follows:—Length over all, 46″; width, 30″; height, 50″, and its weight is 1,000 lbs. It can be taken apart in 10 minutes and set up again, ready for business, in a half hour. It was built with a view to easy transportation in the mountainous country where the hemp-fields are located, and in so doing the expenses of transportation of the hemp trees to the machine, over the long, precipitous and tortuous mountain passes and trials, have been reduced to a minimum. The machine being thus adapted to the actual and existing conditions of the country, it can be worked at very much less expense than a stationary stripper and at a correspondingly greater profit. It can be adjusted to turn out any quality of fiber desired in the market, from the coarsest to the finest grades.

The *Behrendt Process* machine is especially adapted and constructed to permit a quick and thorough separation of the pulp and freeing the fibers without violence or injury to the latter, and at the same time cleaning the fibers entirely of the pulp. After the fiber has been cleaned in the manner just stated, before it passes out of the machine it runs through two rubber rollers which press out the tannic acid which is contained in the plant. This makes discoloration impossible and at the same time the fiber is dried to such an extent that it requires only a few hours of exposure to the sun before it can be baled and shipped to the market. By this process the machine turns out long, round, clean, white and polished fiber of a lustrous and glossy appearance. The loss of fiber by the machine is estimated at from 3 to 5 per cent against the present native method where the loss is from 30 to 40 per cent. The average price that has been paid in Manila for the hemp produced by the machine has been between ₱23 and ₱27 ($11.50 and $13.50 gold) per picul.



BEHRENDT FIBER-STRIPPING AND CLEANING MACHINE, SHOWING ATTACHMENT FOR HAND-POWER OPERATION

The advantages of the machine, condensed, are *(1)* its simplicity, anyone being able to handle it without technical knowledge; *(2)* its portability, which means easy access to the mountains and the material reduction of freight expenses; *(3)* the process, whereby the fiber can be regulated according to the demands of the market; *(4)* the systematic and safe way of extracting the fiber with a very small loss and without violence or injury to the same; *(5)* the safeguards against discoloration by the pressing out of the tannic acid; *(6)* the time gained in the drying of the fiber; and *(7)* the superior quality of fiber produced and the good prices it holds in the market.

The Behrendt machine is the property of Messrs. Behrendt & Co. This firm was organized under the laws of the State of New York, its headquarters being in New York City. The branch office in Manila for the Philippine Islands and the Far East is under the supervision of Mr. Gustave L. Solignac as General Manager. Another office was established in Ligao, Province of Albay, in the month of May, 1906. At this latter place the firm made its first introduction of its hemp machines, Ligao being the central point of most of the large hemp-fields in the Province of Albay. After they had demonstrated to the planters there what the machine could do Messrs. Behrendt & Co. found no trouble in putting the machines to work. Three camps have already been established on three of the largest plantations near Ligao—Camp Lopez Mataos, Camp Muñoz Mataos and Camp Boyer. In all of the camps the machines are working on full time. The firm has the honor of being the first in the field and also of having sent the first shipment of machine-stripped hemp to Manila in all the history of the Philippine Islands.

HONGKONG AND SHANGHAI BANK

Mr. A. Stephen, Ating Manager of the Manila branch of the Hongkong and Shanghai Bangking Corporation, has received the following telegram from the head office of the company in Hongkong:—

"Subject to audit and confirmation at the general meeting of shareholders, the dividend for the six months ended December 31st, 1906, will probably be £1 15/- per share with a bonus in addition of £1 per share; to be added to Reserve, $750,000; and carried forward to next half year Undivided Profits, $1,700,000.

"The directors have resolved to approach the Hongkong Government to amend the Bank Ordinance in order to provide for an increase of capital, and will recommend at an extraordinary general meeting, to be held later, the creation of 40,000 new shares of $125 each to be issued to the shareholders at the price of £35 in the proportion of one new share to two old shares."

The dividend proposed will, with that paid for the half year ended June 30th, make a total dividend of £4 10/- on each share of Mexican $125 for 1906.

The proposed issue of new shares will raise the capital of the bank from $10,000,000 (Mexican) to $15,000,000 and the premium on the issue will amount to about $6,000,000 (Mexican) which, with the existing reserves of $21,000,000 (Mexican), will make the Capital and Reserve of the bank $42,000,000 (Mexican).

WESTERN AUSTRALIA RAILROADS

The railroads of Western Australia, one of the largest states of the Australian Commonwealth, are under Government control, as is the case with all the railways of the commonwealth. Although Western Australia's railway history begins at a date considerably later than that of any of the eastern states of the commonwealth, it is, according to a competent authority, as regards rapidity of construction and growth of traffic, unique in comparison with other systems. As distinguished from previous conditions, when the requirements and agricultural products of the older settlements formed the staple source of railway revenue, this more particularly applies to the last decade when the wonderful gold discoveries in the new districts rapidly developed a large and profitable business. The first railway line of the colony connecting Geraldton with the copper-mining district of Northampton was opened in 1879, and since then nearly 2,000 miles of rail have been laid. The standard gauge is 3′ 6″. The administration of all Government railways open for traffic is in the hands of the Commissioner of Railways. Under a parliamentary enactment of 1904 his responsibilities and powers were fully defined, and the practical operation of the department was removed as far as possible from the control of politicians. For the purpose of ordinary organization of operation the department is divided into four divisions, *viz*, the administration or general, the traffic, the locomotive, and the ways and works, the heads of which are practical railroad men and regarded as well equipped for the positions. The average number of men permanently employed is 6,000. The capital expended on the lines now open amounts to approximately $50,000,000 gold, and the percentage of profit on their operation is between 4.6 and 5 per cent on the money invested. Accidents are infrequent and have rarely resulted in loss of life. The telegraph and telephone systems are also owned by the Government, and have steadily grown in size and efficiency since their establishment. In Western Australia there are now approximately 175 telegraph stations and 10,000 miles of wire. In connection with the telephone exchange over 6,000 miles of wire are in operation, while the railway telephone lines operate nearly 8,000 miles of wire.

STEEL WORKS OF THE ATLANTIC, GULF AND PACIFIC COMPANY

The Atlantic, Gulf and Pacific Company, one of the largest engineering and contracting concerns of the United States and among the first of the big American corporations to extend their business to the Philippines, has just inaugurated a substantial and up-to-date steel works on the left bank of the Pasig River in that district of Manila known as Pandakan. This company has always displayed an abiding faith in the future industrial possibilities of Manila and the Philippine Islands, backing up this faith with the investment of substantial sums of money in large engineering plants and larger contracts, all of which capital is bringing most satisfactory returns through capable and aggressive management. The company's policy has in a measure been unique in that it has always depended almost entirely upon native labor for the accomplishment of its undertakings in the Islands, and so judiciously has this labor been handled that it has always proved reliable and efficient.

A Modern Steel Plant.—The steel works on the Pasig represent an ultimate expenditure of something like $150,000 gold. They occupy a tract of ground that is eight acres in extent, and the site is one of the best for manufacturing purposes to be found in Manila. The plant is fitted out with machinery to fabricate all classes of structural steel work, including bridges, buildings, water tanks—in fact everything built of structural steel. The latest and most modern power machinery, all of American make, has been installed, consisting of punches, shears, planers, lathes, drills, etc. The punches are of the multiple type, punching 17 holes in one motion. The shears are of the rotary type, and there are edge and face planers, cold cutoff saws, steam hammers, and other auxiliaries.

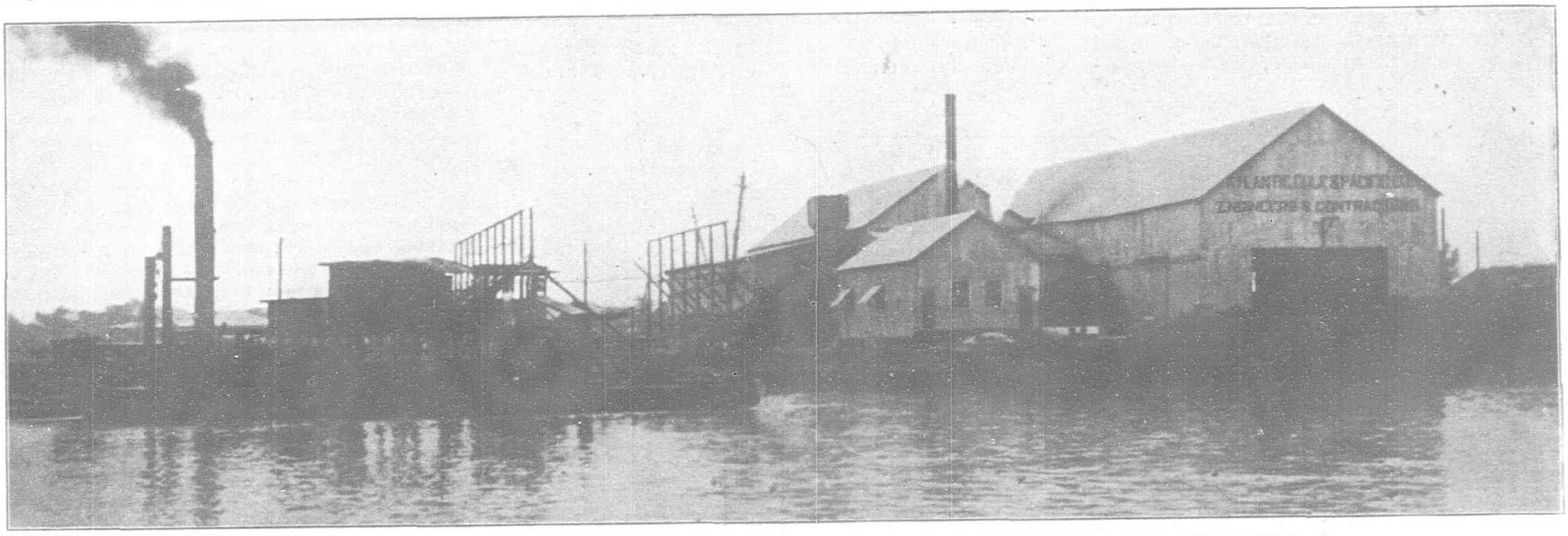
The building has its own electric lighting plant, and steam is furnished by two 300 h. p. boilers. A duplex steam driven air compressor provides compressed air, which is piped through the building, furnishing power for the pressure riveters and other air tools. All riveting, caulking, drilling, reaming, etc., is done with the air tools, and the big air compressor is fitted with automatic attachments which keep the air in the receiver at a uniform compression.

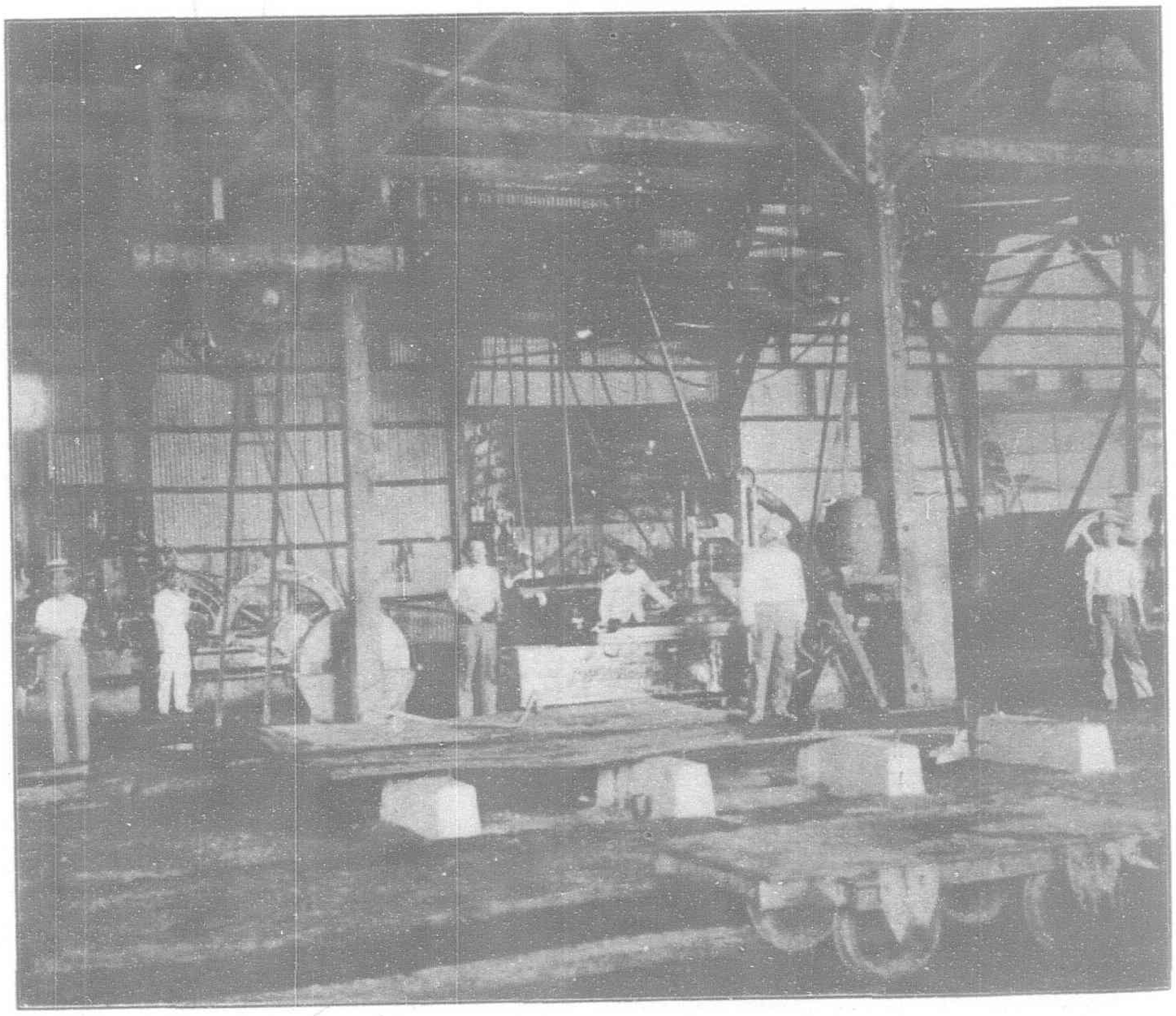
The main engines which drive the machinery are of the Atlas heavy-duty type.

Products of the Plant.—In addition to the structural steel work, machinery has been installed for the manufacture of all kinds and sizes of rivets, bolts and nuts, including railroad bolts and spikes. The merchants of Manila need no longer carry large stocks of rivets, bolts, and other such material as has heretofore been necessary, because the Atlantic, Gulf and Pacific Company is now prepared to furnish all such stock in any quantity at all times.

The Insular Government will also benefit largely from this plant, because it can have its bridges built at home, on native soil and by native workmen, for all the work at the plant is being done by Filipino workmen under American supervision.

Slipway Under Construction.—Within the next six months a slipway, with modern appliances, will be installed and equipped for taking out and repairing small river craft, in addition to the company's own fleet of barges and launches which has now attained considerable size. The facilities for loading and unloading material at the plant are also superb, river craft being able to tie up alongside a spacious wharf on the bank of the Pasig directly in front of the works.

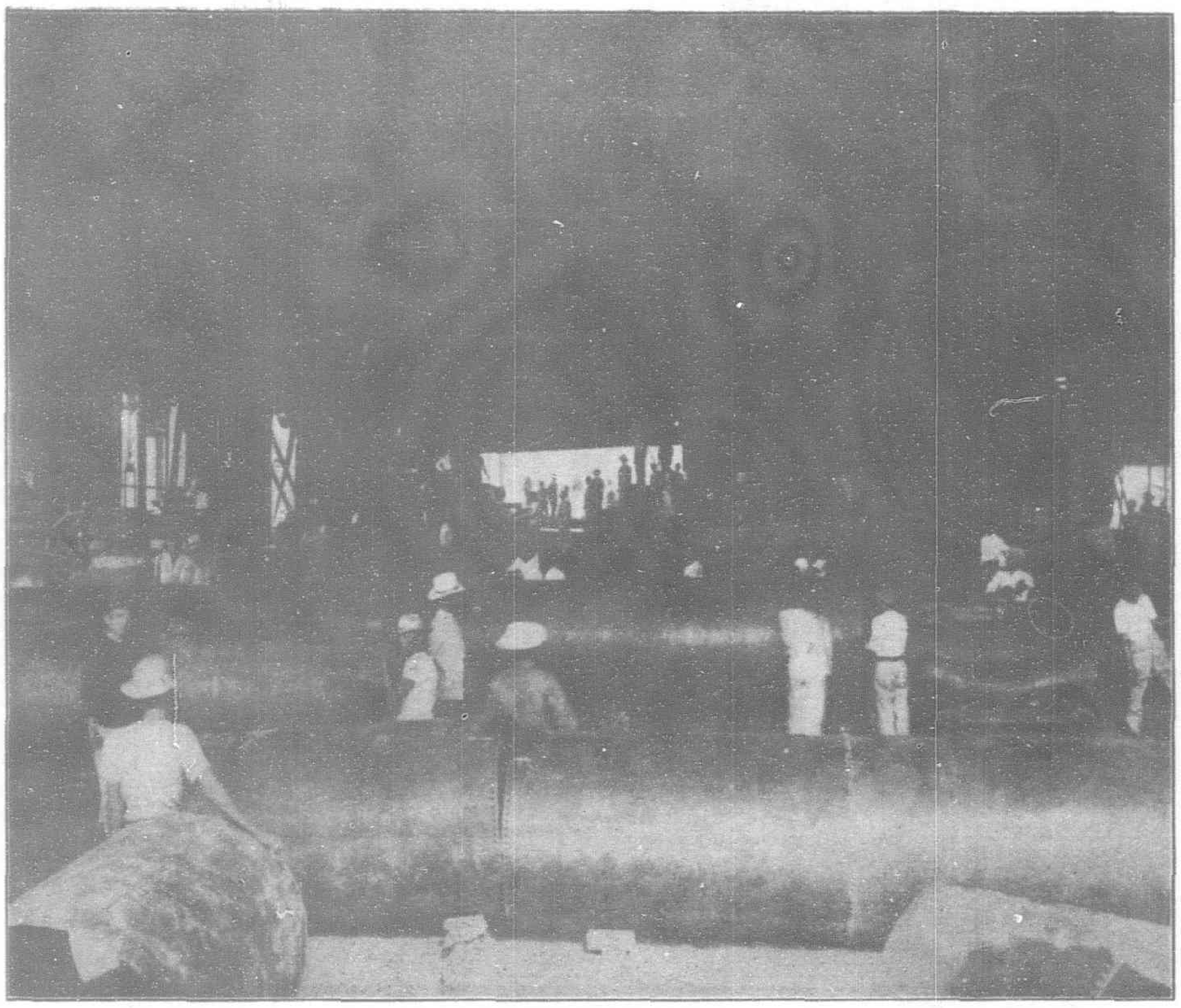

STEEL WORKS OF THE ATLANTIC, GULF AND PACIFIC COMPANY ON THE PASIG RIVER AT MANILA


SECTIONAL INTERIOR VIEW OF THE WORKS

JAPAN'S TEXTILE MACHINERY

Mr. W. A. Graham Clark, special agent of the Bureau of Manufactures of the Department of Commerce and Labor, at Washington, reports that there is an excellent opening in Japan for the sale of power looms and describes the kinds of looms best adapted to the mills of that country. British manufacturers of cotton-mill machinery dominate in that field as in the supply of cotton goods, and some of the reasons for this domination are furnished by Mr. Clark.

At present Japan is a better field for the sale of machinery needed to make finished products than for the manufactured products themselves. In no line of business is this truer than in cotton manufacturing. Japan is straining every nerve to change from a consuming to a producing nation, and a great amount of money will be put into textile machinery the next few years. The tendency of all the mills is to add looms and make cloth for the export trade. The great market for the cloth of the kind that can readily be made by Japan in Manchuria and Korea has stimulated the weave mills, while the year business has to stand severe competition in China and Indian yarn, and at present the yarn market is dull. Many Japanese yarn mills are considering the question of changing to weave mills, and several have recently done so.



INTERIOR VIEW OF THE WORKS SHOWING WATER PIPE FOR THE NEW MANILA GRAVITY SYSTEM

There is at present a fine opportunity for American textile machine manufacturers to gain a foothold in Japan. The textile machinery market is dominated by the English to an even larger degree than the textile market. Reports from England are that textile machinery manufacturers are overwhelmed with orders and can not give quick delivery. Spinning machinery is being turned out at Oldham and elsewhere in vast quantities, and the shops are running overtime. The loom makers in Blackburn and Burnley are turning out more looms per month than ever before and are much behind in orders. Makers of reels, engines, and boilers, etc., are running behind in delivery. Much of this unprecedented activity in textile machinery factories in England is produced by the foreign demand, of which a good portion, like that from Japan, rightfully belongs on account of proximity to the United States.

The first mill in Japan that was a success had English machinery, and the other mills followed. Machinery from Oldham, Blackburn, Burnley, etc., is found in all the Japanese mills, but very little American. There is some prejudice against American textile machinery as being too high in price and too light in construction. Notwithstanding his dexterity in certain lines of manufacture the average Japanese is a very rough workman, and the managers therefore prefer heavy machinery from England instead of the really better-designed American, overlooking the fact that an eyebeam properly constructed is fully as strong as a solid bar, and that in such instances extra metal is useless.

That the English control the market for textile machinery is due entirely to the indifference of American manufacturers. The English, besides having their agencies, send experts out continually, and do everything possible to facilitate buying, American manufacturers paying little attention to the market and even not giving quotations when desired. A local American firm that handles machinery, a little while back, noting the amount of money going to England for textile machinery, wished to see if some of it could not be diverted to America. They accordingly wrote to one of the largest companies manufacturing looms in the United States of the big market, and asked for quotations to see if they could not profitably compete. The answer came back in due time that the firm appreciated his inquiry, but did not care to make any quotations unless they knew the name of the particular mill the machinery would be ordered for. Contrast this with what would have been the result if the circumstances had been reversed and application had been made to England.

The textile machinery imports are increasing rapidly, as shown by the following table:—

	1903.	1904.	1905.	First six months of 1906.
Cotton-printing machinery....	$ 19,629	$ 17,980	$ 11,187	$ 19,403
Cotton-spinning machinery....	267,501	316,942	614,117	556,177
Cotton-weaving machinery ...	39,670	77,418	193,282	66,829
Total......	326,800	412,340	818,586	642,409

Of the $818,586 worth for 1905 there was shipped from the United States only $14,613 of cotton-spinning and $22,512 of cotton-weaving machinery.

There are several new factories being projected, and established mills are enlarging, so if the question of raising more revenue is solved by the Diet without burdening manufacturing too much, there will probably be between 50,000 and 100,000 new spindles installed during 1907. The Kanegafuchi Spinning Company, whose head office is at Kobé, intends to send its superintendent to England to select machinery for a large new mill they have decided to erect at Harima and which they intend to make a model mill.

A new million-dollar mill to be known as the "Oriental" is to be shortly established near Amagasaki, Setsu Province, for weaving calico. The proposed equipment is 500 looms, 20,000 spindles for No. 42 yarn and 10,000 spindles for finer yarn. Mr. Kibuchi Kyozo, of Osaka, has charge of the enterprise.

The Fuhushima mill at Osaka has decided to add 20,000 spindles so as to increase its yarn production for shipment to China.

Several other mills are now being organized and others are ordering additional machinery. Most of these orders will be placed this fall for spring shipment, and it affords a good chance for the introduction of American spindles and looms, as previously explained.

There is a prejudice among Japanese mill managers against American textile machinery. They assert that it is higher in price, lighter in construction, and takes more repairs. The mills were equipped with English machinery and were at first operated by Englishmen, and the Japanese naturally cling to what they have been accustomed, but if American manufacturers seize the present opportunity to get a foothold in the market and to prove the labor-saving qualities of the American textile machinery this prejudice can be removed.

For the last year the Kanegafuchi Spinning Company, which is the largest in Japan and operates 218,080 spindles, has been conducting at its head mill in Kobé an experiment to determine the best loom. It installed 100 looms, of which 10 were plain looms from Draper Company, Hopedale, Mass.; 30 plain looms from Platt Brothers (Limited), Oldham, England; 12 Platt looms with warp stop motions; 30 plain looms from the Toyoda Shokwai Company at Nagoya, Japan; and 18 Toyoda looms with warp stop motions.

The trial resulted in favor of the English looms without stop motions and looms have been ordered from England to replace the Japanese looms.

The 100 looms have been running on 44 by 44, 36″, 3½-yard shirting, making cuts 40 yards long, weighing 13 lbs. The yarn was a mixture of Indian, Chinese, and American. In blending three cottons of differing length of staple, different color, different texture and feel, and different spinning qualities, great skill is shown by the Japanese, but it is impossible for the resulting yarn to be as strong as yarn made from pure American cotton; and if too much twist is put in it kinks too badly. For this reason warp stop motions cause too much stoppage of the loom for coarse plain cloth, and are very much opposed by the operatives.

The American looms were given a black eye at the start by coming out in a broken-up condition due to bad packing and to rough handling, while the English looms arrived ready for work. While admitting that the American loom with American operatives is all right, the main argument made by the Japanese against its use is that it is badly designed for this market and that, as compared with the heavier English make, the breakage is excessive. This is due to the rough handling that is given the looms by Japanese operatives and loom fixers. The Japanese loom is inferior in weaving qualities and could not stand the usage.

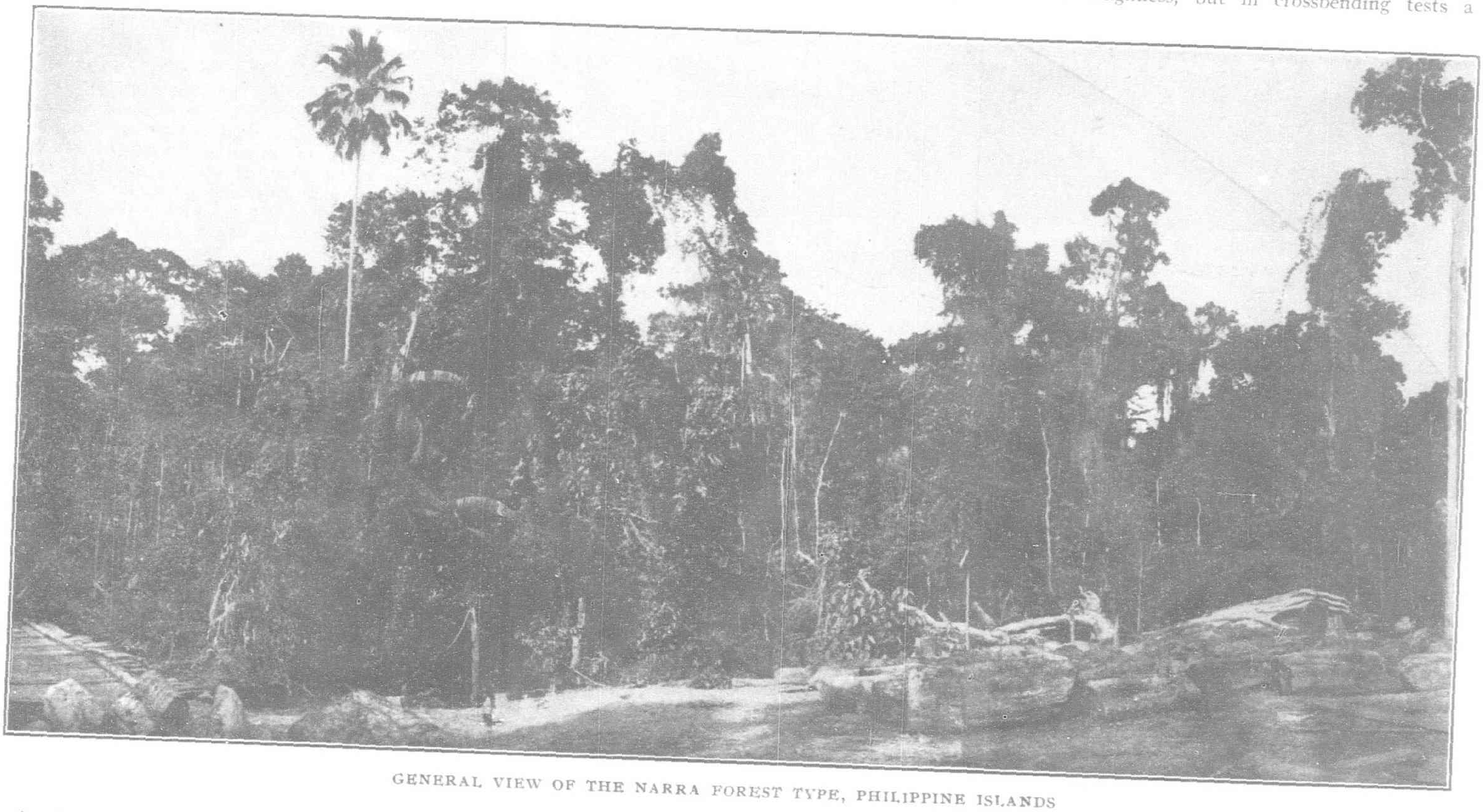
Owing to the many mills now changing or proposing to install looms, the Kanegafuchi will probably remain on yarn, though there is talk of its building a shirting factory to replace English shirting. It is the largest mill in Japan, however, so the results of the tests are important for their effect on other mills. The present price of American plain looms is about -Y-185 c.i.f. and English -Y-170.

One Japanese cotton mill, the Tsushima Spinning Company in Owari Province in Central Japan, operates 100 looms on 1 shaku print cloth, but the majority of the immense quantity of narrow prints made and used so extensively for kimonos are made on hand looms. The price is from -Y-1.80 to 2.80 per bolt, or 4½ to 7 cents per yard. In addition to the narrow cotton prints, which were the main exhibit of cotton piece goods, there were also interesting exhibits of the goods made in the mills in Japan, comprising mostly gray sheetings, drills, T cloth, cotton crape, and cotton flannel, also some duck and shirtings and twills.

YALU LUMBER BUSINESS.—According to the Peking Treaty the lumber business on the banks of the Yalu River is to be a coöperative enterprise of Japanese and Chinese. It has been decided to establish a coöperative company with a capital of about $1,750,000 gold, to be equally divided between the two nationalities. As soon as the conditions, which have been forwarded to the Chinese Government by the Foreign Office of the Japanese Government, are accepted, the latter Government proposes to appoint a special inauguration committee similar to that of the South Manchurian Railway Company and proceed with floating the company.

Mechanical Tests, Properties and Uses of Philippine Woods

Mr. Rolland Gardner, manager of the timber-testing laboratory of the Bureau of Forestry of the Philippine Government, has compiled some interesting facts covering mechanical tests and the properties and uses of 30 Philippine woods, together with data regarding the local sawmills and the lumber market, and prices. The whole has been published in the form of a bulletin in response to numerous inquiries concerning Philippine woods and milling operations in the archipelago. The results of the timber tests represent the present knowledge of the subject and are not to be considered final, for such results can be obtained only from a large number of tests of properly identified botanical material from many localities and habitats. With two exceptions, the woods tested have been representative of the commercial material found on the market and are fair samples of those used by contractors and engineers. Indeed, in many instances they represent more approximately an average of the actual material used in construction than woods collected with botanical specimens might do. Nevertheless the value of mechanical tests on properly determined material obtained from districts where logged is not underestimated by the bureau, and such tests will be made as rapidly as possible.



GENERAL VIEW OF THE NARRA FOREST TYPE, PHILIPPINE ISLANDS

Qualities of Woods and Meaning of Timber Tests.—Every woodworker knows, says Mr. Gardner, more or less of the properties of the various kinds of woods which come under his observation, but this knowledge is usually gained by long experience. He may know that certain woods are strong or stiff, but he seldom learns from his own experience how strong or stiff they are. For this reason the design of structures is often a matter of guess-work, the designer or builder not having experimental data regarding the strength, stiffness and other properties of timber. In the timber testing laboratory these various properties and characteristics are studied and the results are collected in such form that others may use them to determine the fitness of woods for certain purposes.

Timber, as a material of construction, is required to resist various stresses. A short, thick column must resist simple compression along the grain. A railroad tie must resist compression across the grain where the rail rests upon it, and also shearing across the grain by the edges of the rail. Simple tension and shearing along the grain are not common in practice, although these stresses frequently occur in combination with other stresses, as in cross bending. It is possible to subject timber to any one of the above mentioned stresses, but it is much more common in practice that timber must withstand a number of these stresses at the same time.

Timber also possesses such properties as stiffness, hardness, toughness, flexibility, etc., which are all important in determining the fitness of any wood for certain purposes. Strength and stiffness are measured in pounds per square inch, but no satisfactory units have yet been proposed by which such properties as hardness and toughness may be measured.

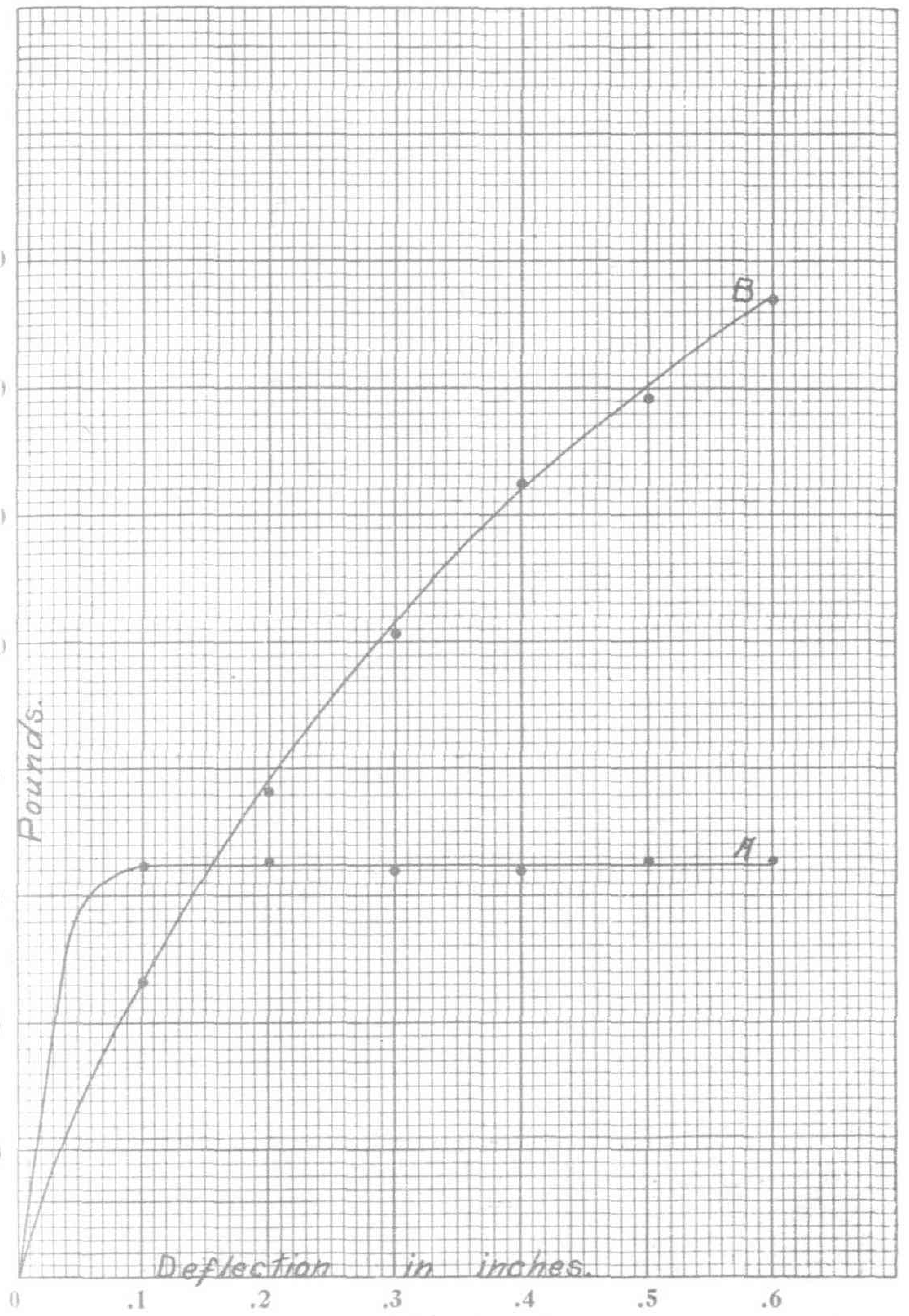
The beam is one of the most common members in general construction and the stresses involved are most complex. Suppose we have a beam 4×4″ in section, 5′ long, and supported at each end. At the middle of this beam a load of 500 lbs. is applied and the beam bends 1-16″ at the middle; another 500 lbs. bends it 1-16″ more, and soon until a point is reached where an added 500 lbs. produces an additional deflection of more than 1-16″. Here the true elastic limit is reached, or, to state this little more accurately, the true elastic limit is reached when flection is no longer proportional to load. This is approximately the point where the material begins to be injured, and if a beam is loaded beyond this point it will not return to its original condition when the load is removed. Even small loads produce some permanent set or bend in beams, but the true elastic limit is important as showing approximately the point where injury begins. Thus the true elastic limit is located. Now what do the (average) figures mean which are tabulated under "Fiber stress at the true elastic limit, pounds per square inch?" Evidently not the load on the beam when the true elastic limit was reached, for that would be applicable only to a beam of the same size, under exactly the same conditions as the one tested. To answer this question, it is necessary to examine the stresses produced.

As the beam is bent, its curve is approximately the arc of a circle. The bottom of the beam becomes longer and the top shorter, therefore the bottom is in tension and the top in compression. Upon the supposition that these stresses are equal, the average stress at the extreme top and bottom of the beam is computed and is tabulated under "Fiber stress at true elastic limit, pounds per square inch."

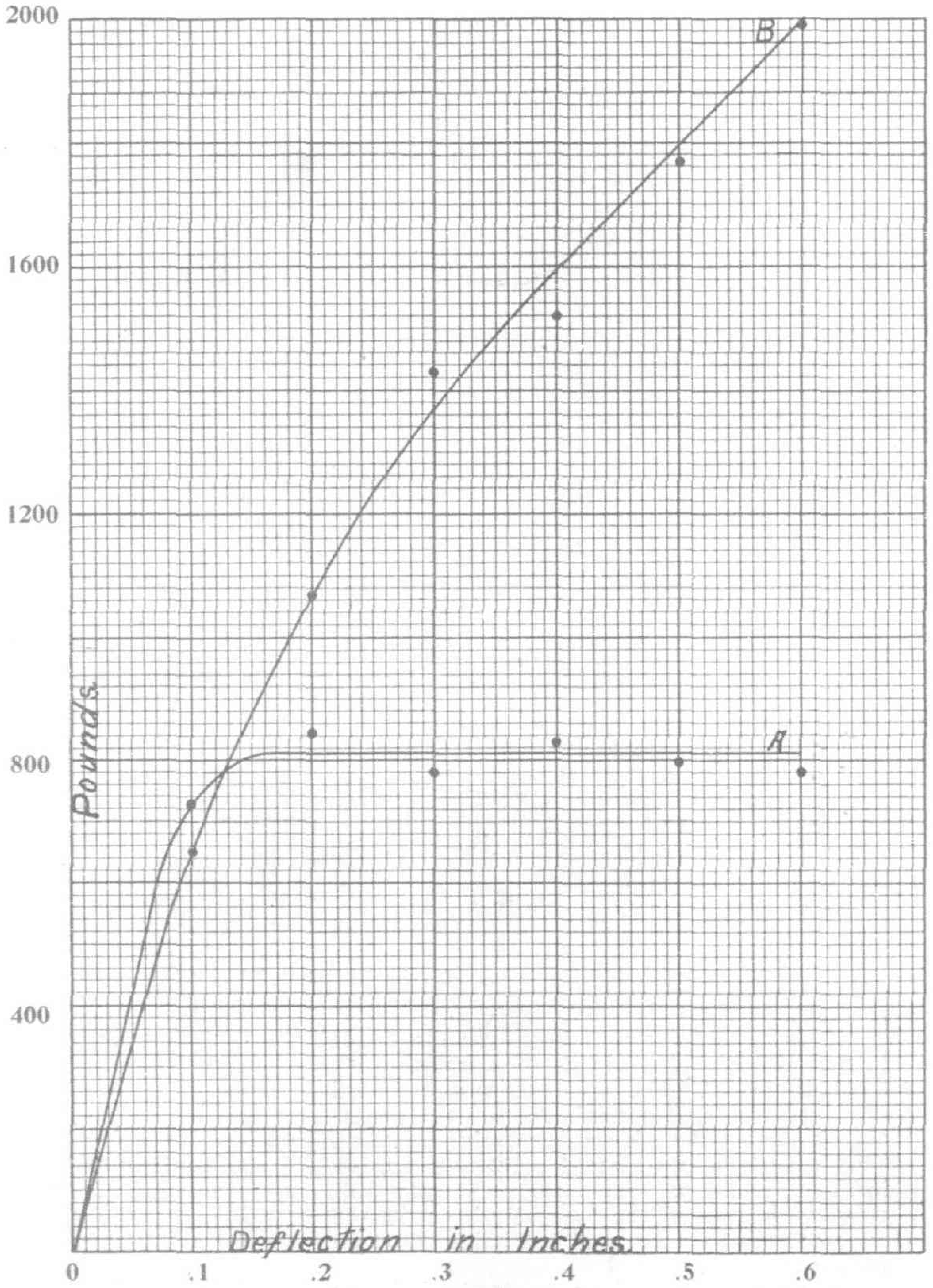
Fiber stress at apparent elastic limit and modulus of rupture, as tabulated, are also approximate stresses at the extreme top and bottom of the beam. The apparent elastic limit is a point a little higher than the true elastic limit. It is located arbitrarily, as explained under "Methods of testing and results of tests," and has no particular significance, although it was used extensively in early timber tests. The true elastic limit may be considered as a limit of safety and the modulus of rupture as the greatest stress which the wood will stand in cross bending. In practice, the fiber stress is always kept much lower than the fiber stress at the true elastic limit.

No attempt is made to measure brittleness and toughness, but in crossbending tests a brittle wood may be distinguished from a tough wood by the relation existing between the true elastic limit and rupture, for in brittle woods the amount of bending is small between the true elastic limit and rupture, while in tough woods it is great. Most Philippine woods are brittle, Dungon and Malugay being the only ones which have been investigated and found to possess the property of toughness to any considerable degree. These two, however, are quite tough and compare favorably with White Oak for bending by steaming. Woods like Molave, Calantas, Ash, and Pine are brittle, while those like Malugay, Dungon, Elm, Hickory, and Oak are tough.

The modulus of elasticity is the measure of the stiffness of a material. If a beam of one kind of wood has a modulus of elasticity of 1,000,000 lbs. per square inch, and a second beam of another kind has a modulus of elasticity of 2,000,000 lbs. per square inch, the second wood is twice as stiff as the first, and if the two beams are of exactly the same dimensions, the first beam will bend twiec as far as the second



COMPRESSION ACROSS THE GRAIN—LAUANG GROWN IN MINDANAO—18 TESTS; AVERAGE PERCENTAGE OF MOISTURE, 35.5; AVERAGE SPECIFIC GRAVITY (DRY), 0.441



COMPRESSION ACROSS THE GRAIN—APITONG GROWN IN MINDANAO—23 TESTS; AVERAGE PERCENTAGE OF MOISTURE, 36; AVERAGE SPECIFIC GRAVITY (DRY), 0.632

under a given load. For example, Yacal and Guijo are among the stiffest Philippine woods, being aproximately twice as stiff as woods like Banuyo and Calantas. (*See Table I.*)

Now consider two similar beams of the same material, supported at each end and loaded in the middle. If beam No. 1 is made twice as long as beam No. 2, other dimensions being the same, it will bend eight times as far under a given load but will be only half as strong. If beam No. 1 is made twice as high as beam No. 2, other dimensions remaining the same, it will bend only one-eighth as far under a given load but will be four times as strong. If beam No. 1 is made twice as wide as beam No. 2, other dimensions remaining the same, it will bend only one-half as far but will be twice as strong. If the beams are of the same dimensions throughout and the load on beam No. 1 is double that on beam No. 2, beam No. 1 will bend twice as far.

A strong wood is not necessarily stiff, nor is a stiff wood necessarily strong, although in many cases these properties appear to be closely related. By referring to Table I, it is seen that the Betis, from Tayabas, which was tested, was about 60 per cent stronger in cross bending than that from Ambos Camarines, although it was not quite as stiff. With few exceptions timber is much stronger when dry than when green. The weight of moisture in timber just from the saw is often from 80 to 90 per cent of the weight of the wood itself. This amount of moisture may be reduced to 30 to 35 per cent of the weight of dry wood, without showing any increase in strength, but when the wood is dried beyond this point the strength usually increases quite rapidly, well-seasoned timber frequently being from 50 to 70 per cent stronger than green timber.

As wood dries, the fibers become harder, stiffer, and stronger, but the wood also shrinks, which causes checks that tend to weaken the timber. In most woods this latter effect is much less than the former and the wood shows a decided increase in strength and stiffness, but in hard brittle woods the checking effect is quite serious. The tendency to check while seasoning may be overcome to a large extent by drying slowly and evenly, but in large timbers the outer surface dries months or even years before the interior, so that it is practically impossible to prevent checking. This is one reason why the strength values for large timbers are somewhat smaller than for small timbers.

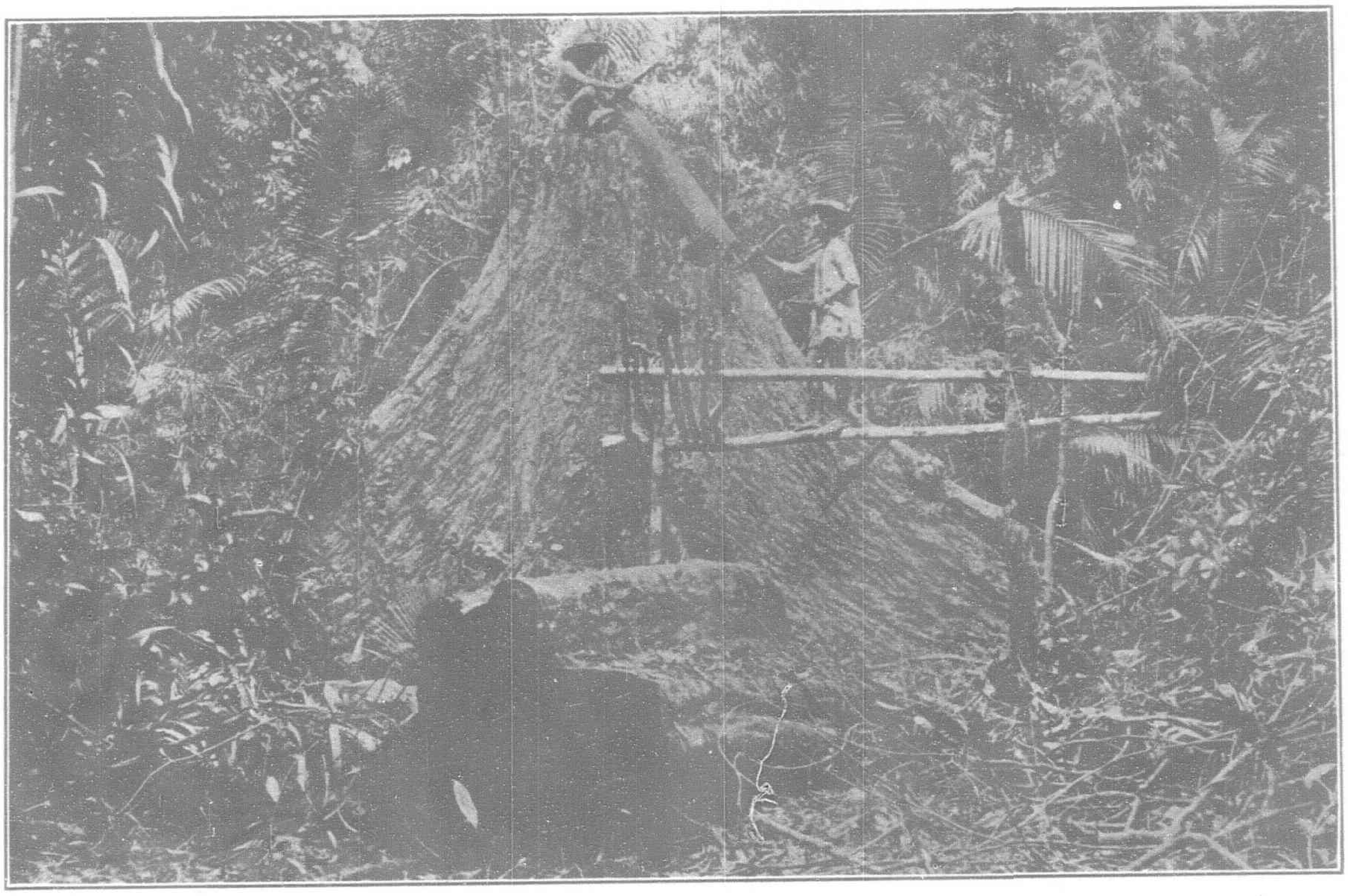
Timber is thoroughly seasoned when it contains 10 to 12 per cent moisture throughout, and will arive at that percentage of moisture in time if exposed to air but protected from rain and sun. If it is made drier than this by artificial means, it will reabsorb moisture from the atmosphere until it arrives at 10 to 12 per cent moisture. There is considerable variation in the moisture content of timber seasoned by artificial means. Usually timber whose moisture content is less than 20 per cent will pass for seasoned timber.

In tropical countries the most desirable quality sought in wood is durability. This is true because the destructive elements to timber are greater than in temperate regions. Because of continuous heat and moisture, fungus growth is undoubtedly more rapid in the Tropics. The universal presence of the white ant is perhaps the most destructive element that makes the use of durable timber almost imperative for railroad ties and for general construction purposes. Such timbers as are used for ties in cold regions would not last nearly as long here as there, but some of the best native woods are extremely durable. In temperate zones ten years is considered a long life for an untreated tie, but in these Islands the extremely durable woods, like Ipil and Molave, are known to have been in the ground for more than ten years without any sign of decay. The ravages of the sea worm (*teredo*) restrict the use of untreated timber, in contact with salt water, to those species that are especially adapted to resisting the attacks of this enemy. The softer Philippine woods, like Lauan, and imported woods, like Oregon Pine, are quickly destroyed when placed in salt water, while Aranga and Betis are highly valued because of their great durability under these conditions.

It being impracticable at the time these tests were started to secure timber which had been botanically determined, this series of tests was made almost entirely upon timber purchased in the market. The Sacat and Balacat, which were obtained at the Lamao Forest Reserve, were the only woods which were not secured in the market. In buying care was exercised to select timber which well represented the quality generally used in construction. Most of the timber tested was clear and sound.

No standard rules for the inspection of timber are in use in Manila by which the quality and condition of the timber tested may be described. All blocks used for compression and shear tests were clear and sound.

METHODS OF TESTING AND RESULTS OF TESTS.—The machine used in making the following tests is a Tinius Olsen testing machine, with a capacity of 200,000 lbs.



CUTTING OUT A TABLE TOP FROM A BUTTRESS OF NARRA, DELTA OF THE BONGABON RIVER, EAST COAST OF MINDORO

All beams used for cross-bending tests (Table I) were either $3\frac{1}{2} \times 3\frac{1}{2}''$ or $4 \times 4''$ in section, with a span of 60″. The machine was operated at a speed of 0.3″ per minute and the deflection was noted at various loads during the tests. The curve was then plotted between deflection in inches and load in pounds, and upon this curve were located the true elastic limit, the apparent elastic limit, and the point at which failure occurred.

The fiber stress at the true elastic limit was calculated by the standard formula:—

Fiber stress at true elastic limit $= \frac{3WL}{2BH^2}$ where

W=load in pounds at true elastic limit,

L=span in inches,

B=breadth of beam in inches,

H=height of beam in inches.

The term "apparent elastic limit," as used in this bulletin, is defined as follows:—

"The apparent elastic limit is the point on the stress diagram of any material in any kind of a test at which the rate of deformation is 50 per cent greater than it is at the origin."

The fiber stress at the apparent elastic limit and the modulus of rupture were determined by the same formula which was used to determine the fiber stress at the true elastic limit, *viz*:—

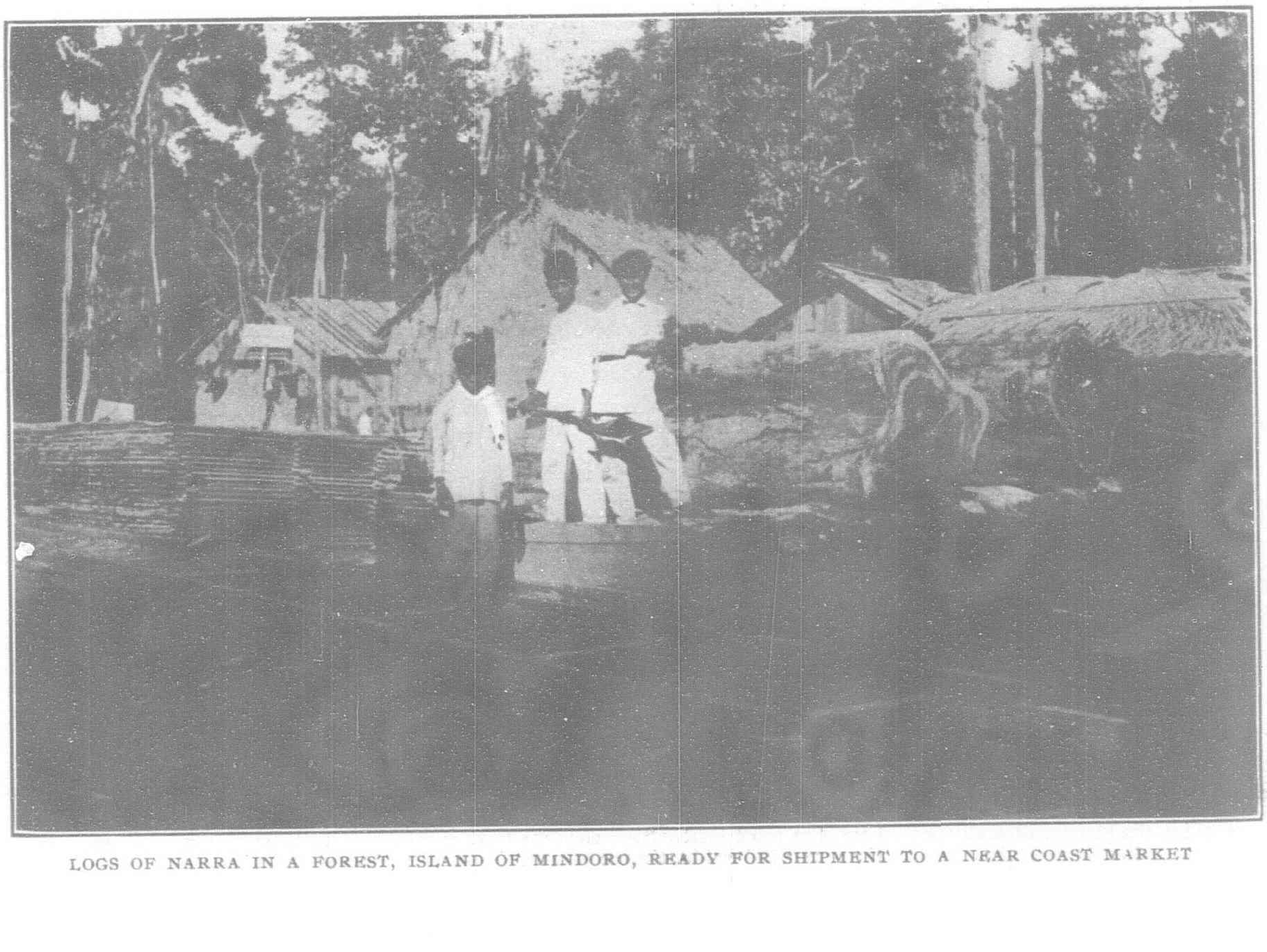
Fiber stress at the apparent elastic limit $= \frac{3W'L}{2BH^2}$ where,

W'=load in pounds at the apparent elastic limit; and

Modulus of rupture $= \frac{3W''L}{2BH^2}$ where,

W''=load in pounds at rupture.

Plate I shows the true elastic limit and the apparent elastic limit as located upon a typical stress diagram.



LOGS OF NARRA IN A FOREST, ISLAND OF MINDORO, READY FOR SHIPMENT TO A NEAR COAST MARKET

After the stress diagram was drawn, a tangent was drawn to the curve at the origin and the modulus of elasticity was determined by the following well-known formula:—

Modulus of elasticity$=\frac{W\ L^3}{4\ D\ B\ H^3}$ where,

W=the load corresponding to some point on the tangent,

D=the deflection in inches corresponding to the same point,

B=the breadth of beam in inches,

H=the height of beam in inches,

L=the span in inches.

After the cross-bending test, the beams were cut up for compression tests, shear tests, and moisture determinations.

The blocks for tests in compression along the grain (*Table II*) were either $3\frac{1}{2}\times3\frac{1}{2}''$ or $4\times4''$ in cross section and 8″ high. The machine was operated at a speed of 0.06″ per minute and the load was increased until the blocks showed signs of failure by wrinkling on the sides.

TABLE I.—*Average Cross-Bending Strength of Philippine Timber*

Name.	Locality.	Moisture over 35 per cent.						
		Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).
Lauan	Mindanao	38	51.8	0.444	2.630	4,570	6,870	1,464
Do	Zambales	36	63.	.478	5,260	6,410	8,040	1,438
Apitong	Mindanao	52	53.9	.62	3,750	5,550	7,350	1,754
Do	Zambales	30	55.8	.679	5,220	6,790	8,910	1,428
Guijo	Ambos Camarines	27	43.7	.677	6,330	8,660	12,050	1,915
Do	Mindoro	49	57.8	.696	6,420	8,780	1,350	1,825
Molave	Laguna de Bay	47	45.5	.772	4,870	8,380	10,610	1,503
Do	Amb. Camarines	29	54.4	.782	6,840	8,640	10,380	1,381
Yacal	do	21	43.3	.823	7,270	10,160	13,070	2,079
Narra	Laguna de Bay	11	79.	.563	3,000	6,300	8,390	1,509
Do	Cagayan	11	51.8	.63	6,020	7,960	10,220	1,352
Tanguile	Unknown	8	39.9	.536	5,180	6,780	9.160	1,576
Do	Zambales	27	47.7	.457	4,010	4,980	6,380	1,241
Sacat	Bataan	8	48.5	.561	3,340	5,030	6,960	1,584
Do	Tarlac	42	55.2	.60	5,800	7,050	9,300	1,569
Ipil	Amb. Camarines	19	52.7	.79	4,360	6,690	7,960	1,295
Do	Mindoro	44	63.1	.67	5,450	7,430	9,410	1,226
Do	Palawan	41	52.2	.807	9,170	11,210	13,520	1,953
Dungon	Amb. Camarines	6	42.2	.824	5,660	7,400	11,770	1,680
Do	Masbate	3	36.3	.827	4,730	6,420	10,250	1,593
Do	Mindanao	21	49.4	.668	4,520	5,740	7,870	1,317
Malasantol	Unknown	21	66.2	.633	4,500	6,480	8,690	1,518
Supa	do	5	37.3	.673	6,410	8,180	10,050	1,435
Do	Tayabas	12	38.7	.755	4,890	7,170	8,700	1,415
Balacat	Bataan	9	56.1	.517	5,120	6,280	8,540	1,293
Do	Tarlac	21	45.4	.56	5,210	6,200	7,780	1,221
Macaasin	Unknown	35	68.4	.695	4,370	6,120	8,660	1,416
Calantas	Albay	15	75.4	.357	3,000	4,240	5,650	.961
Do	Mindoro	10	57.3	.511	3,560	4,900	6,250	.940
Tindalo	Unknown	6	40.4	.747	8,090	10,770	15,000	2,226
Do	Amb. Camarines	12	44.7	.808	7,070	9,700	11,330	1,588
Do	Masbate	10	59.	.77	5,290	7,690	11,200	1,536
Amuguis	Mindoro	31	46.1	.692	4,490	6,800	9,780	1,697
Acle	Tarlac	41	92.5	.632	3,920	6,000	7,270	1,069
Do	Zambales	6	96.8	.579	5,900	7,010	9,080	1,213
Betis	Tayabas	7	38.1	.849	5,780	8,460	11,910	1,768
Do	Amb. Camarines	30	61.6	.725	3,670	5,620	7,450	2,035
Bansalaguin	Unknown	18	46.2	.841	6,820	9,420	11,740	1,702
Palo Maria	Zambales	24	56.	.623	5,840	7,040	8,930	1,461
Batitinan	Unknown	10	54.4	.777	4,540	6,350	9,320	1,427
Banuyo	Masbate	16	82.	.522	2,900	4,170	5,140	881
Balacbacan	Occ. Negros	9	40.	.538	5,410	6,320	8,180	1,280
Mayapis	Laguna	20	67.7	.399	4,070	5,320	6,760	1,133
Malugay	Mindoro	18	57.2	.635	4,780	6,930	10,280	1,627
Liusin	Bataan	14	60.9	.71	5,430	8,120	11,360	1,896
Lumbayao	Basilan Islands	2	37.1	.545	5,620	6,460	7,790	1,160

TABLE II.—*Average Compressive Strength Along the Grain of Philippine Timber.*

Moisture over 35 per cent.

Name.	Locality.	Number of tests.	Moisture (per cent.)	Specific gravity of dry wood.	Stress at rupture (pounds per square inch).
Lauan	Mindanao	67	52.4	0.444	3,840
Do	Zambales	70	59.5	.478	4,180
Apitong	Mindanao	98	53.	.617	4,350
Do	Zambales	60	53.4	.679	5,010
Guijo	Amb. Camarines	50	41.8	.675	6,070
Do	Mindoro	98	55.7	.697	6,070
Molave	Laguna de Bay	78	46.4	.772	6,680
Do	Amb. Camarines	50	50.5	.784	6,530
Yacal	do	34	46.7	.828	7,490
Narra	Laguna de Bay	20	77.7	.563	5,780
Do	Cagayan	18	55.9	.619	5,300
Tanguile	Unknown	18	40.5	.53	4,750
Do	Zambales	54	44.1	.46	3,980
Sacat	Bataan	14	49.8	.561	4,530
Do	Tarlac	74	53.1	.60	5,260
Ipil	Amb. Camarines	36	52.9	.796	5,650
Do	Mindoro	84	60.4	.666	5,450
Do	Palawan	79	51.4	.807	8,090
Dungon	Amb. Camarines	6	44.1	.803	6,160
Do	Masbate	6	36.9	.825	4,540
Do	Mindanao	38	50.7	.669	4,000
Malasantol	Unknown	40	64.4	.631	4,660
Supa	do	8	36.1	.677	6,480
Do	Tayabas	10	37.2	.746	5,090
Balacat	Bataan	16	52.6	.517	4,020
Do	Tarlac	40	44.7	.56	4,150
Macaasin	Unknown	76	63.9	.703	4,350
Calantas	Albay	28	77.3	.357	2,960
Do	Mindoro	18	57.3	.51	3,810
Tindalo	Unknown	12	41.9	.747	7,400
Do	Amb. Camarines	23	43.9	.80	7,140
Do	Masbate	20	56.7	.77	5,930
Amuguis	Mindoro	54	45.2	.692	5,210
Acle	Tarlac	27	84.5	.631	4,550
Do	Zambales	12	94.9	.579	5,330
Betis	Tayabas	14	38.2	.854	6,540
Do	Amb. Camarines	60	59.5	.725	4,330
Bansalaguin	Unknown	34	43.	.841	6,960
Palo-Maria	Zambales	40	50.2	.618	4,770
Batitinan	Unknown	18	54.9	.777	4,650
Banuyo	Masbate	30	77.9	.527	3,290
Balacbacan	Neg. Occidental	4	43.	.546	4,410
Mayapis	Laguna	40	63.5	.399	3,530
Malugay	Mindoro	34	55.8	.635	5,120
Liusin	Bataan	8	60.9	.71	5,220

SHEAR ALONG THE GRAIN.—The pieces used for shear tests were either $1\frac{1}{2}$ or $1\frac{3}{4}''$ thick. 3″ wide, and 18″ long. Just 1″ from one end of the piece a hole was cut $\frac{5}{8}\times1''$, through which a rectangular steel bar was placed. The opposite end of the test piece was then gripped in the upper jaws of the machine and the load was applied on the steel bar until the material directly under it was sheared out. It will be seen that this arrangement produces double shear, the area being either 3 or $3\frac{1}{2}$ square inches, depending upon the thickness of the piece. For these tests the machine was operated at a speed of 0.3″ per minute.

TABLE III.—*Average Shearing Strength Along the Grain of Philippine Timber.*

[Results averaged regardless of moisture content.]

Name.	Locality.	Number of tests.	Specific gravity, dry wood.	Stress at rupture (pounds per square inch).
Lauan	Mindanao	142	0.446	557
Do	Zambales	69	.478	525
Apitong	Mindanao	150	.645	669
Do	Zambales	62	.687	757
Guijo	Ambos Camarines	110	.708	915
Do	Mindoro	98	.697	824
Molave	Laguna de Bay	129	.784	914
Do	Ambos Camarines	51	.784	839
Yacal	do	150	.843	849
Narra	Laguna de Bay	20	.563	678
Do	Cagayan	59	.54	660
Tanguile	Unknown	70	.471	647
Do.	Zambales	86	.491	555
Sacat	Bataan	14	.561	776
Do	Tarlac	132	.616	850
Ipil	Ambos Camarines	79	.793	904
Do	Mindoro	90	.673	948
Do	Palawan	80	.807	753
Dungon	Ambos Camarines	98	.852	1,253
Do	Masbate	46	.85	1,298
Do	Mindanao	44	.669	855
Malasantol	Unknown	54	.646	720
Supa	do	86	.71	898
Do	Tayabas	118	.813	852
Balacat	Bataan	16	.517	486
Do	Tarlac	117	.578	692
Macaasin	Unknown	92	.717	916
Calantas	Albay	34	.358	526
Do	Mindoro	35	.527	778
Tindalo	Unknown	20	.763	1,004
Do	Ambos Camarines	56	.805	911
Do	Masbate	36	.772	905
Amuguis	Mindoro	60	.692	824
Acle	Tarlac	36	.63	686
Do	Zambales	11	.579	778
Betis	Tayabas	38	.856	1,168
Do	Ambos Camarines	61	.728	819
Bansalaguin	Unknown	48	.85	1,098
Palo Maria	Zambales	46	.623	856
Batitinan	Unknown	26	.795	859
Aranga	Ambos Camarines	82	.863	1,038
Banuyo	Masbate	38	.525	596
Balacbacan	Negros Occidental	34	.543	689
Mayapis	Laguna	40	.399	472
Malugay	Mindoro	78	.658	980
Sasalit	Zambales	75	.872	1,176
Liusin	Bataan	8	.71	886
Lumbayao	Basilan Island	104	.565	827

COMPRESSION ACROSS THE GRAIN.—Compression across the grain, as it usually occurs in practice, is a combination of simple compression over a given area and shearing and bending of the material along the edges of that area. It was desired, if possible, to determine just what part of the load went into simple compression and what part was used in shearing and bending the material along the edges of the area compressed. The following method was adopted and has proven very satisfactory:—

Pieces $4\times4''\times6'$ were used. The piece to be tested was laid upon the table of the machine and the load was applied to castiron blocks laid across the test piece. Two tests were made upon each piece; one with an iron block 2″ wide and one with an iron block 6″ wide, the material under the iron block being compressed 0.6″ unless it showed a decided point of failure before that deflection was reached. If no point of failure could be detected, 0.6″ deflection was assumed arbitrarily as the point of failure.

Let W equal the load necessary to apply on the 6″ block to produce a given deflection, and let W′=the load necessary to apply on the 2″ block to produce the same deflection, then W—W′=the load which would produce that deflection upon an area $4\times4''$ by simple compression—that is, without the support usually given by the material along the edges of the area over which the load is applied; therefore, $\frac{W-W'}{16}$=the stress of simple compression in pounds per square inch. This quantity will be called P.

Now, to determine the part of the load which is used in bending the material along the edges the test with the 2″ block will be considered.

The area under compression is 8 square inches; therefore, 8P=the part of the load which produces simple compression, and since W′=the total load applied, W′—8P=the part of the

PAGATPAT KNEES; TREES GROWING IN SALT WATER, ISLAND OF MINDANAO

load which bends and shears the fiber along the edges of the block, and $\frac{W'-8P}{8}$ = the stress in pounds per linear inch, which produces bending and shearing of the fibers and will be called *p*.

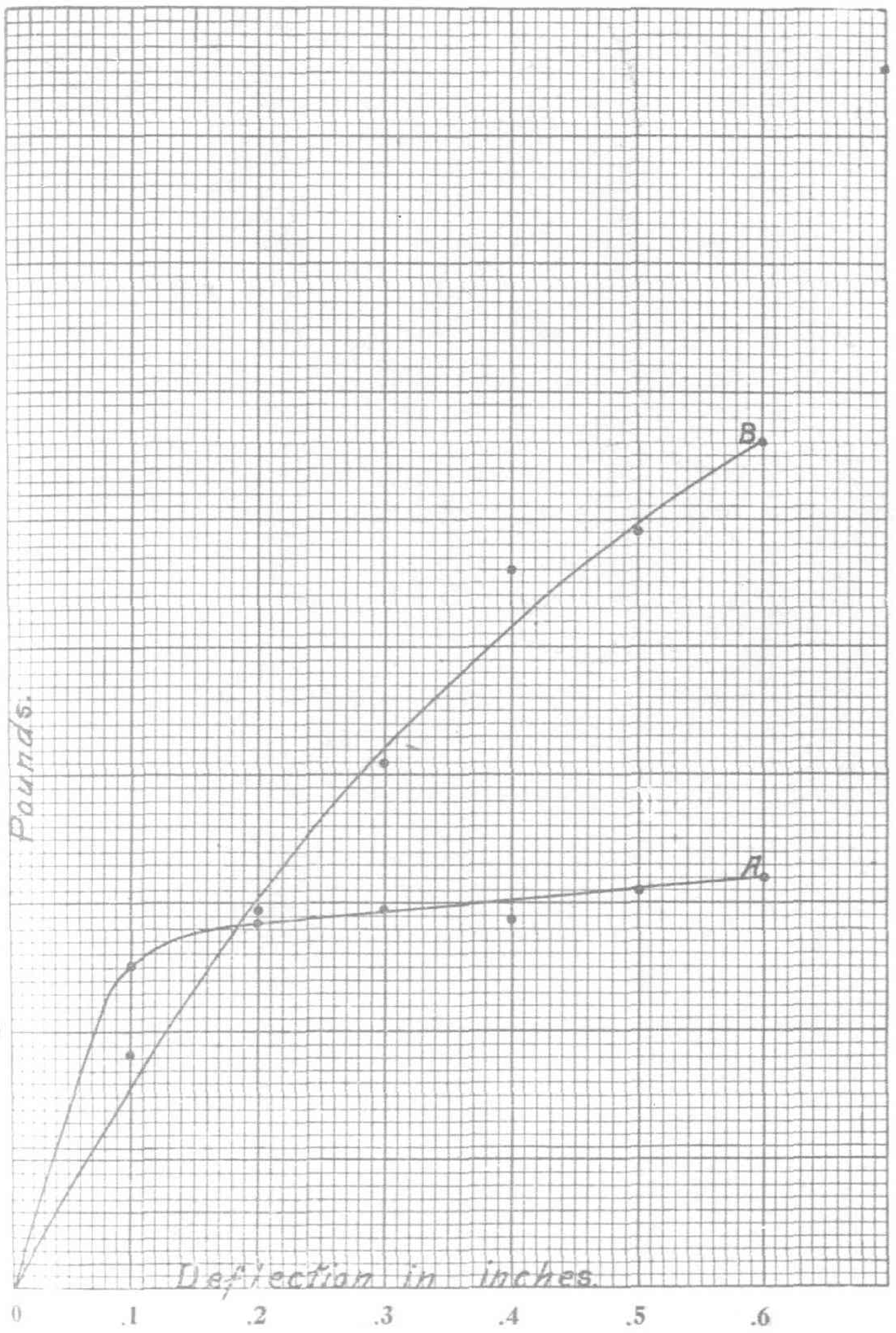
For small deflections and large areas, *p* may usually be neglected, but it increases rapidly as the deflection increases, and for large deflections and small areas which have their greater dimension extending across the grain, *p* is a very important factor, often much more important than P. P and *p* are very nearly independent of the area under consideration, and may therefore be used in all ordinary cases of compression across the grain.

In the accompanying plates of tests values of P are represented by curves A, and values of *p* by curves B. All specimens which were tested were clear and sound.

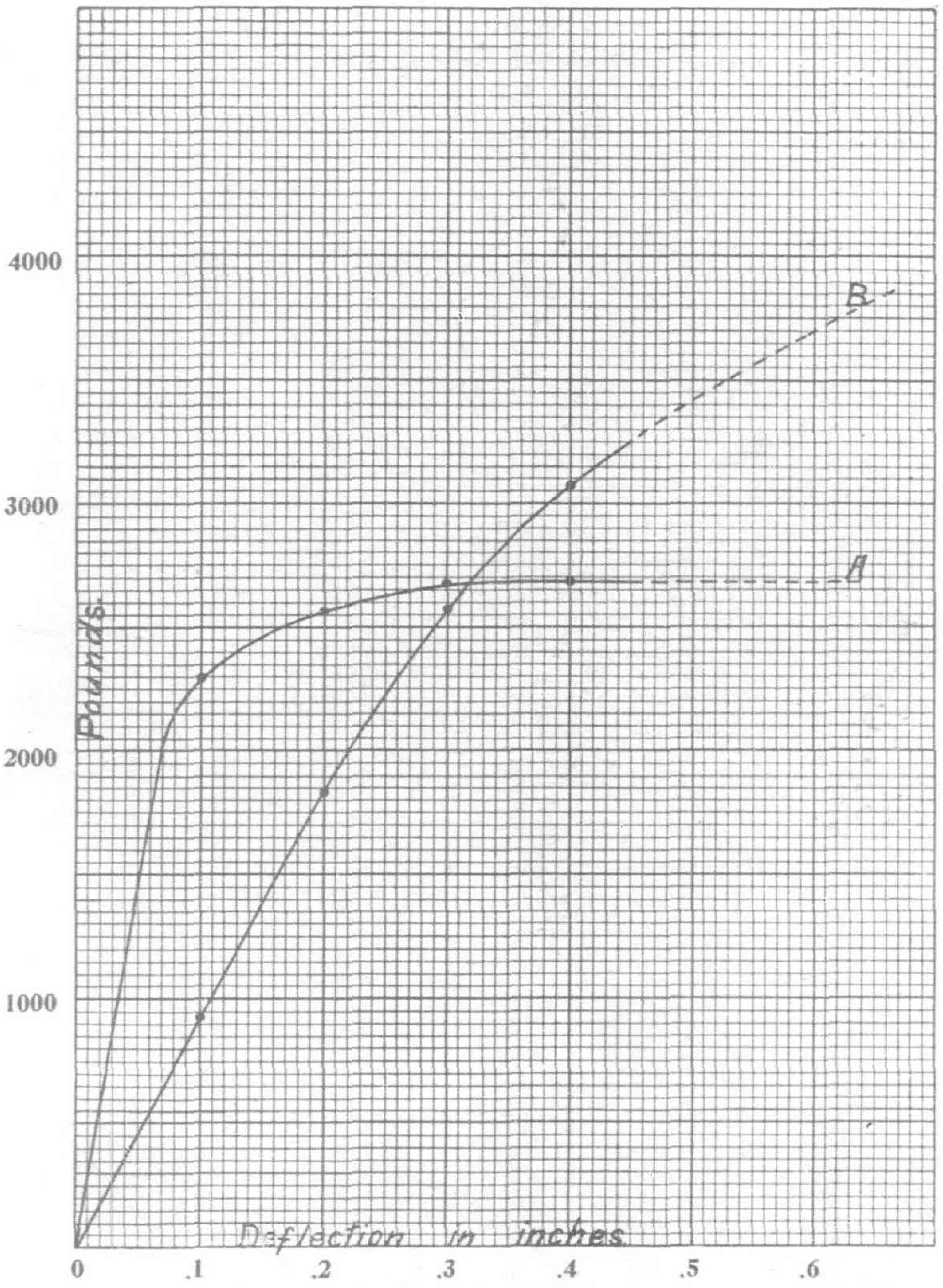
MOISTURE DETERMINATIONS.—Moisture discs were cut about $\frac{3}{8}''$ thick. They were weighed as soon as cut and then placed in a small, steam dry kiln, having a temperature of 110° C., until they were dried to constant weight and then weighed again. The difference between the original weight and the weight after drying was considered as the weight of the moisture, and the percentage of moisture was determined with reference to the dry weight.

SPECIFIC GRAVITY.—In all cases the specific gravity was determined from the full-sized beam. After the moisture content was determined, the results were averaged to obtain the average percentage of moisture for the entire beam and the specific gravity was determined

SWAMPING DONKEY ENGINE IN NEGROS OCCIDENTAL



COMPRESSION ACROSS THE GRAIN—GUIJO GROWN IN AMBOS CAMARINES—8 TESTS; AVERAGE PERCENTAGE OF MOISTURE, 35.4; AVERAGE SPECIFIC GRAVITY (DRY), 0.692



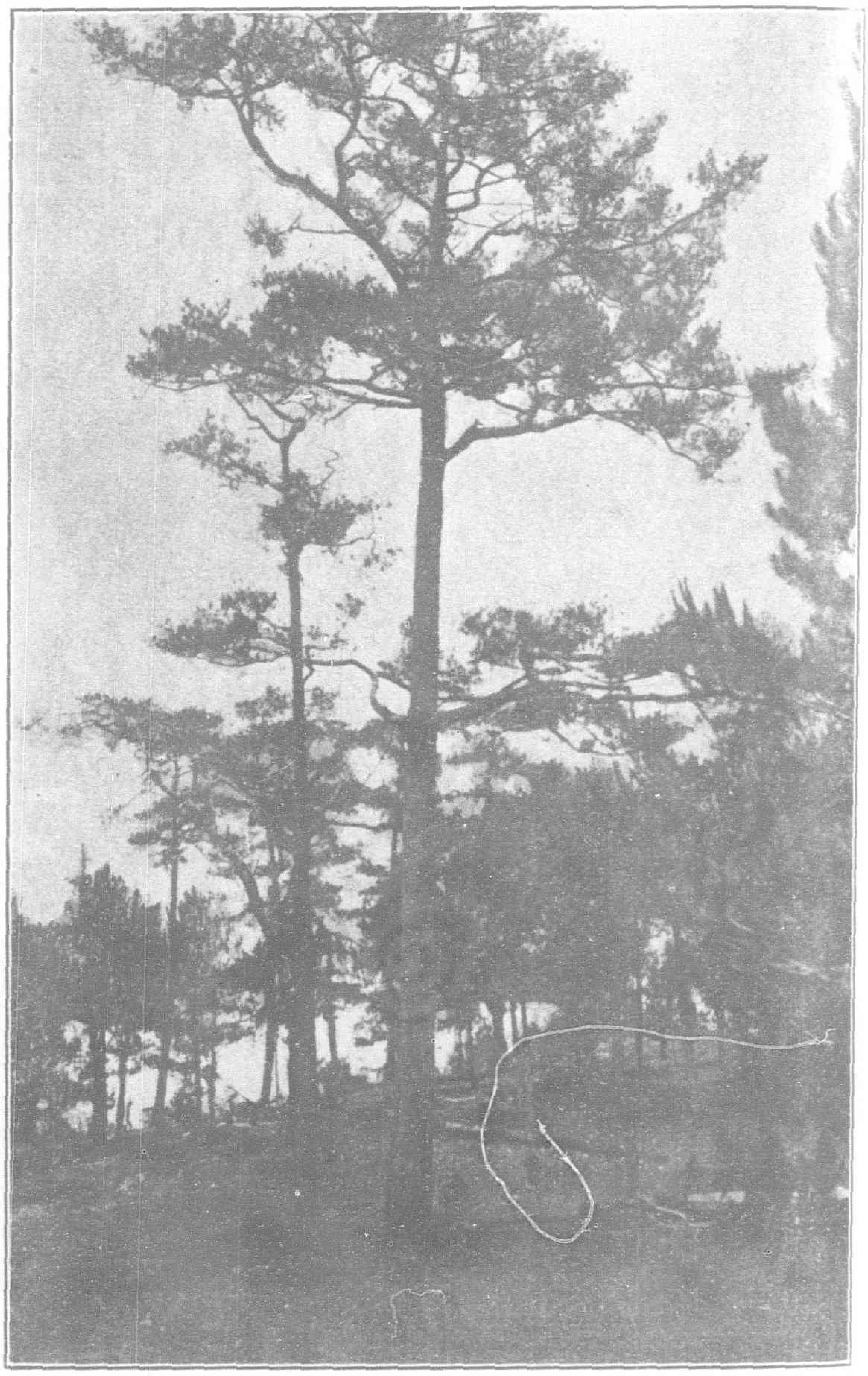
COMPRESSION ACROSS THE GRAIN—MOLAVE GROWN NEAR LAGUNA DE BAY—24 TESTS; AVERAGE PERCENTAGE OF MOISTURE, 24.1; AVERAGE SPECIFIC GRAVITY (DRY), 0.76

for dry wood. For these tests, the following arbitrary classification for heaviness is made: Light, less than 0.50; moderately heavy, 0.50 to 0.70; heavy, 0.70 to 0.90; very heavy, over 0.90. Thus Lauan would be classed as light; Apitong, moderately heavy; Yacal, heavy; and Ebony, very heavy.

HARDNESS.—While hardness is an important property of all materials of construction and has received considerable attention by technologists, there is great diversity of opinion as to how this property shall be defined, tested, and measured. No measure of hardness has yet been proposed which is entirely satisfactory for all materials. The woodworker says a wood is hard if it resists penetration by woodworking tools. This is probably as satisfactory a definition as can be given, and the tests made by this Bureau are based upon this conception of hardness. For lack of a better method, a scale of hardness for woods has been arranged in the following manner:—Representative samples of the various species were selected for this test. The pieces were seasoned and one surface of each was carefully smoothed. Across the grain of each smoothed surface a hardened steel point was drawn, with a pressure of 3.3 lbs. The depth of the scratch produced was considered a measure of hardness. On such woods as Ebony and Bansalaguin the steel point had very little effect, while on California Redwood and Calantas it made a ragged scratch 1-32″ or more in depth. No claim is made for great accuracy by the above method and it is possible that the order of hardness may be altered slightly if a more satisfactory test can be devised.

STRUCTURAL QUALITIES, USES AND SIZES OF PHILIPPINE TIMBER.—*Lauan.*—A light and soft wood which takes a fair polish. It is not durable in the ground or when exposed to the sun and the rain. It seasons well, is usually free from defects and is not inclined to split or check. On a coastal plain in Mindoro the average diameter of 575 trees over 16″ of Lauan is 26″. On the lower slopes of Mount Silay, in Negros Occidental, the average diameter of 885 trees over 16″ of Almon is 28.″ The average merchantable length of 15 measured trees of this species is 88.′ The Lauan of Tayabas has a maximum diameter of 35″ and a clear length of 102′. *Apitong.*—A moderately heavy, hard wood that is fairly durable and usually clear and sound. It shrinks considerably in drying, but does not check badly. Apitong has a reddish color. It is straight but rather coarse grained. Apitong is used in ordinary construction, in shipbuilding, and for inferior furniture. On a coastal plain in Mindoro the average diameter of 73 trees over 16″ of Apitong is 26.″ In Negros the average diameter of 1,051 trees over 16″ is 24″, and the average merchantable length of 13 measured trees is 62′. The sizes given are thought to be low, for a large percentage of the Negros trees measured had been injured by tapping for resin. The Apitong of Tayabas has a maximum clear length of 100′ and a maximum diameter of 45″. On a coastal plain in Mindoro the average diameter of 161 trees over 16″ is 26″. In a similar habitat in Baler, Tayabas, the average diameter of all the trees on 31 acres 8″ and over is 21″. The maximum diameter is 53″, and the average clear length is 86′. *Guijo.*—The wood of Guijo is moderately heavy, hard, strong, brittle, fairly durable, and usually free from defects. It is inclined to warp and check in drying. Guijo has an ashy red color and is straight grained. Guijo is used in general construction and shipbuilding, for carriage wheels and shafts, for flooring and girders of houses, and for inferior furniture. On a coastal plain in Mindoro the average diameter of 168 trees over 16″ is 25″. For Baler, Tayabas, the average diameter for trees over 8″, measured on 81 acres, is 13″, the maximum diameter 35″, and the average clear length 39′. In Southern Tayabas there is a reported maximum diameter for Guijo of 40″ and a maximum clear length of 88′. *Molave.*—The wood of Molave is hard, heavy, and brittle. It is almost impervious to decay and is not attacked by the anay (white ants). It checks slightly in seasoning. Heart checks and small knots are quite frequent. The heartwood of Molave is pale yellow and the sapwood is only slightly lighter in color. The wood is very fine and usually cross-grained. The wood of Molave is most highly valued for general building purposes, where durability is essential. It is used in shipbuilding; for posts, sleepers, and interior trim of houses; and in cabinetmaking and turnery. There is a reported maximum diameter of 45″ and a maximum clear length of 24′ for Molave in Tayabas. The tree is usually irregular in shape, with heavy large branches, a part of which may be utilized. *Yacal.*—The wood of Yacal is heavy, hard, strong, elastic, and quite durable. It breaks in long splinters. Yacal has a dirty yellow color and is rather coarse but straight grained. Yacal is used in general construction and in shipbuilding, and is particularly valuable for beams on account of its stiffness and high modulus of rupture. There is a reported maximum diameter of 33″ and a maximum clear length of 52′ for Yacal from Tayabas. The tree attains sizes considerably larger than this in other provinces. One tree was measured at Santa Maria, Zamboanga, that had a diameter of 48″. *Narra.*—The wood of Narra is moderately heavy, moderately hard, very durable, and is seldom, if ever, attacked by the anay (white ant). It seasons well when properly treated and takes a fine finish. The heartwood of Narra is white, yellow, or red, and the sapwood nearly white. The grain is rather fine, but irregular, and very beautiful when quarter sawn. Narra is used principally

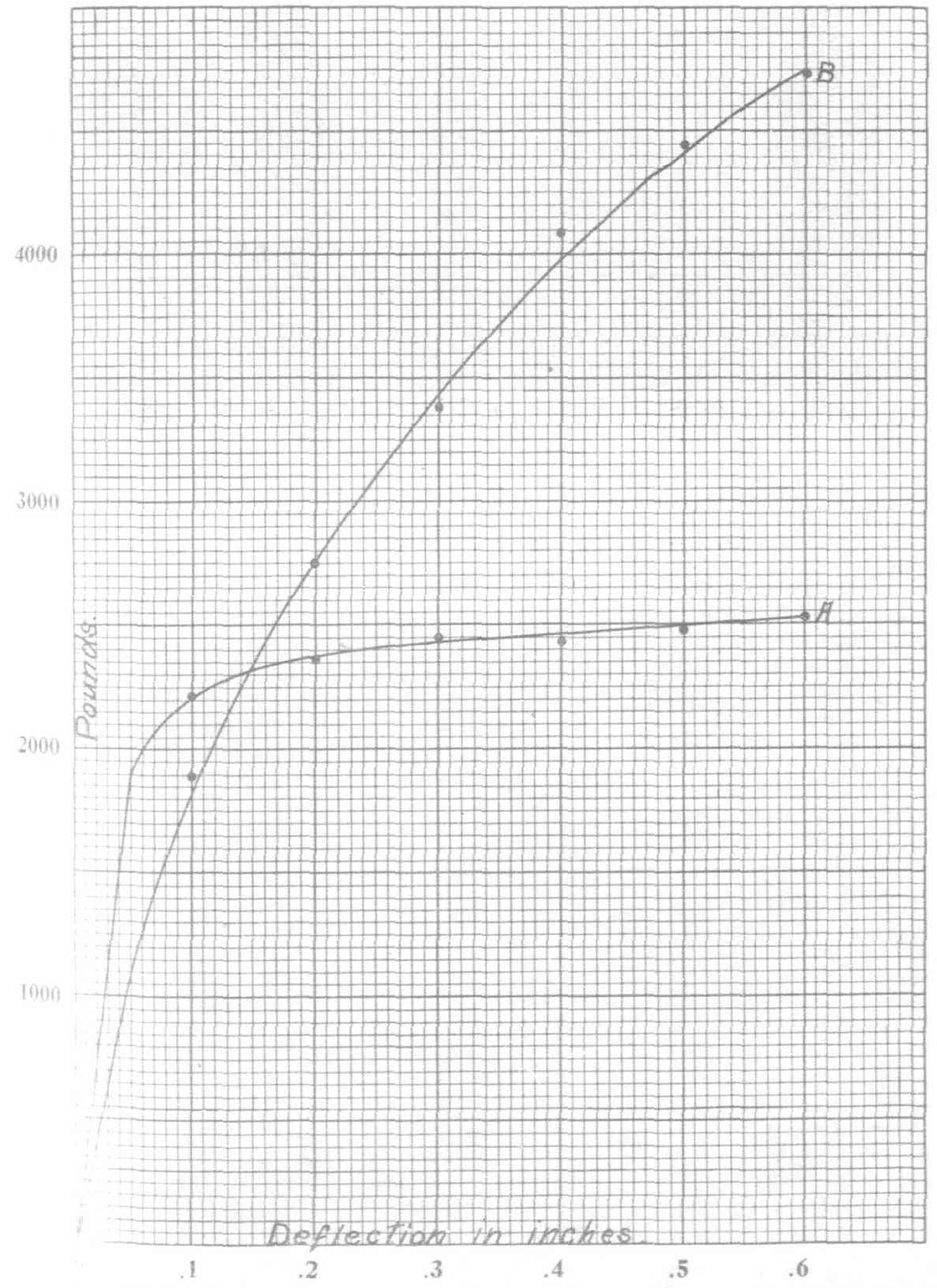
SKIDDING LOGS BY MAN-POWER, ISLAND OF MINDANAO



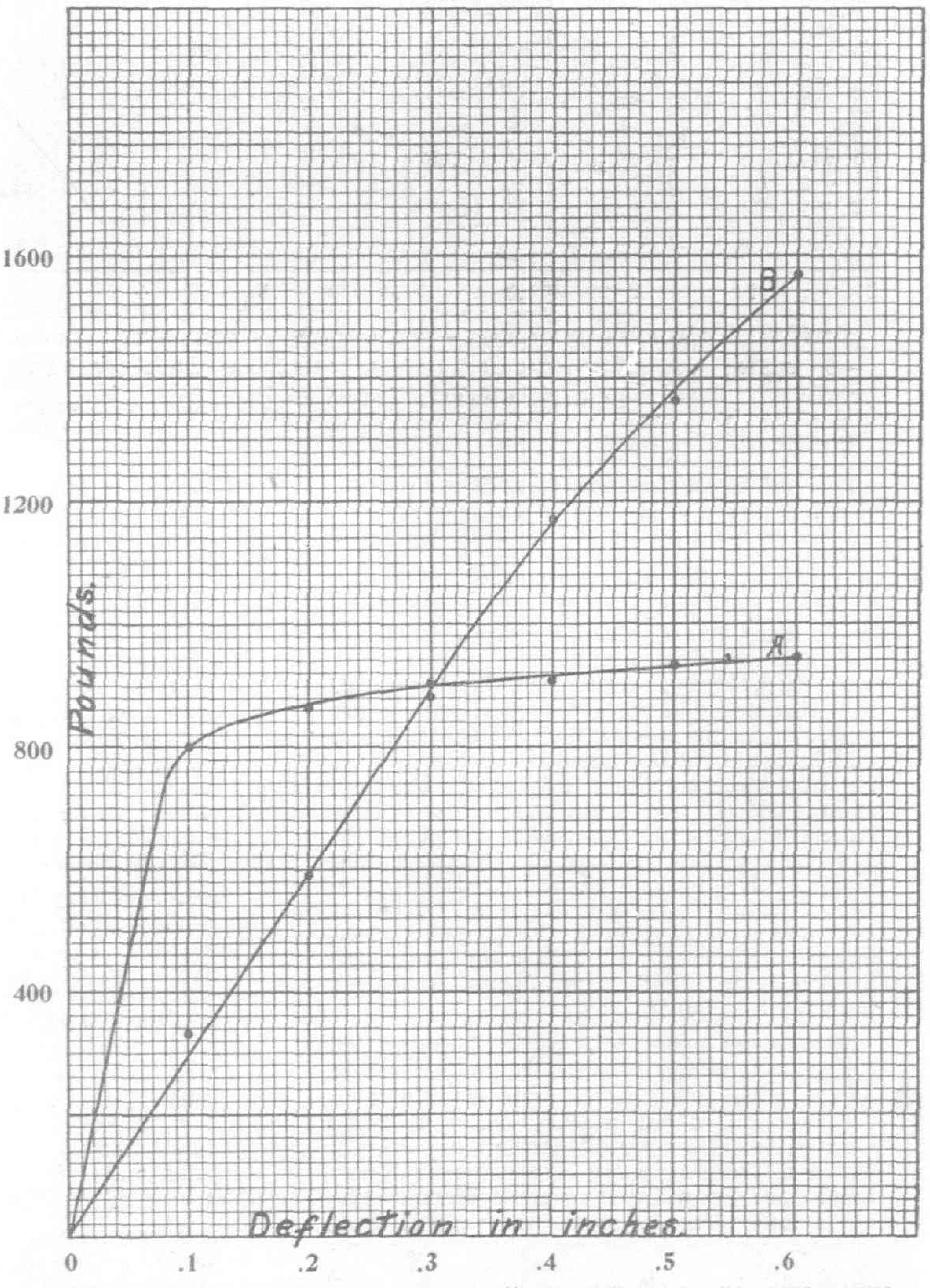
PINE TREES IN THE PROVINCE OF BENGUET, ISLAND OF LUZON

for fine furniture, cabinetmaking, and interior house trim. On a coastal plain in Mindoro the average diameter of 137 trees 16″ and over of Narra is 29″. In a similar habitat in Baler, Tayabas, the average diameter of all Narra trees 8″ and over, on 31 acres, is 25″, the maximum diameter is 50″, and the average clear length is 25′. In Southern Tayabas Narra has a recorded maximum diameter of 40″ and a maximum clear length of 40′. Narra is divided commercially into two varieties, called Red and Yellow. *Tanguile.*—A light, moderately hard structural timber that varies considerably in quality. It is not durable in the ground or when exposed to the sun and rain. The heartwood of Tanguile is frequently unsound. Tanguile is light reddish brown in color and is rather coarse grained. The wood is used in light and medium grade construction and is highly prized for small boats. See "Balachacan" for size. *Sacat.*—A moderately heavy and moderately hard wood. It is not very durable in the ground or when exposed to sun and rain. Sacat is yellow and gray in color, and is coarse but straight grained. Sacat is used in light construction. *Ipil.*—Moderately heavy to heavy, hard, strong, almost impervious to decay, and is seldom, if ever, attacked by the anay (white ant). Ipil is light yellow to dark brown in color. The grain is usually straight. It takes a beautiful dark-brown finish. Ipil is used for general first-class construction, especially posts of houses; for sleepers, and for furniture and cabinetmaking. Sleepers made of this wood have been buried for more than 10 years without showing any signs of decay, consequently it is highly valued for railroad ties. On a coastal plain in Palawan the average diameter of 60 trees 18″ and over, is 24″, and the average clear length of 20 trees is 29′. *Dungon.*—Moderately heavy to heavy, strong, tough, durable, and very hard. It is difficult to work, is inclined to warp, and heart checks are numerous. Dungon has a chocolate-brown color and a fine, close grain. Dungon is used in first-class construction where strength and durability are essential; in naval construction, and as piles and posts. It is also valued in construction where bending by steaming is necessary, as for boat ribs. There is a recorded maximum diameter of 34″ and a clear length of 47′ for Dungon found in Tayabas Province. *Malasantol.*—Malasantol is a moderately heavy structural timber. It is moderately hard and fairly durable. Malasantol is reddish brown in color, and straight but coarse grained. Malasantol is used in general construction. *Supa.*—A good structural timber, being heavy, hard, strong, and fairly durable. It is easily worked and seasons well. Supa is yellow and brown in color and is fine grained. Supa is used in general construction, in flooring, in interior house trim, and for furniture and cabinetmaking. Near Baler, Tayabas, the average diameter of all trees 8″ and over, on 81 acres, is 15″, the maximum diameter is 38″, and the clear length is 40′. *Balacat.*—Balacat is a moderately heavy, soft, inferior wood, which is not durable when exposed. This wood is white to light brown in color, and is coarse grained. Balacat is used in light or temporary construction. *Macaasin.*—Macaasin is a good structural timber, being moderately heavy, hard, strong, and fairly durable. It seasons well. Macaasin is brown in color and rather fine grained. Macaasin is used in general construction; as flooring, joists, and rafters of houses, and in cabinetwork. *Calantas.*—Moderately heavy, very soft, and not very strong, but is quite durable. It is easy to work and takes a good polish. It seasons well and is not inclined to shrink, warp, or check. Calantas has a reddish color and is fine grained. Calantas is highly valued for cigar boxes. It is also used for small boats; in furniture, cabinet and pattern making, and for carving. In Mindoro a recorded maximum diameter of 90″ and a total height of 180′ is given for Calantas. Few trees are found, however, that have a diameter of more than 60″. The boles are usually straight and cylindrical. *Tindalo.*—The wood of Tindalo is heavy, hard, stiff, strong, and durable above ground. It is prized for beams because of its high modulus of rupture. It seasons well and breaks in long splinters. Tindalo is yellowish red in color. It is fine and usually straight grained, but occasional pieces are found having the appearance of bird's-eye maple. It takes a beautiful finish. Tindalo is highly valued for fine furniture and cabinetmaking. It is also used for construction purposes above ground. In Baler, Tayabas, the average diameter of all trees 8″ and over, on 81 acres, is 12″ and the maximum diameter is

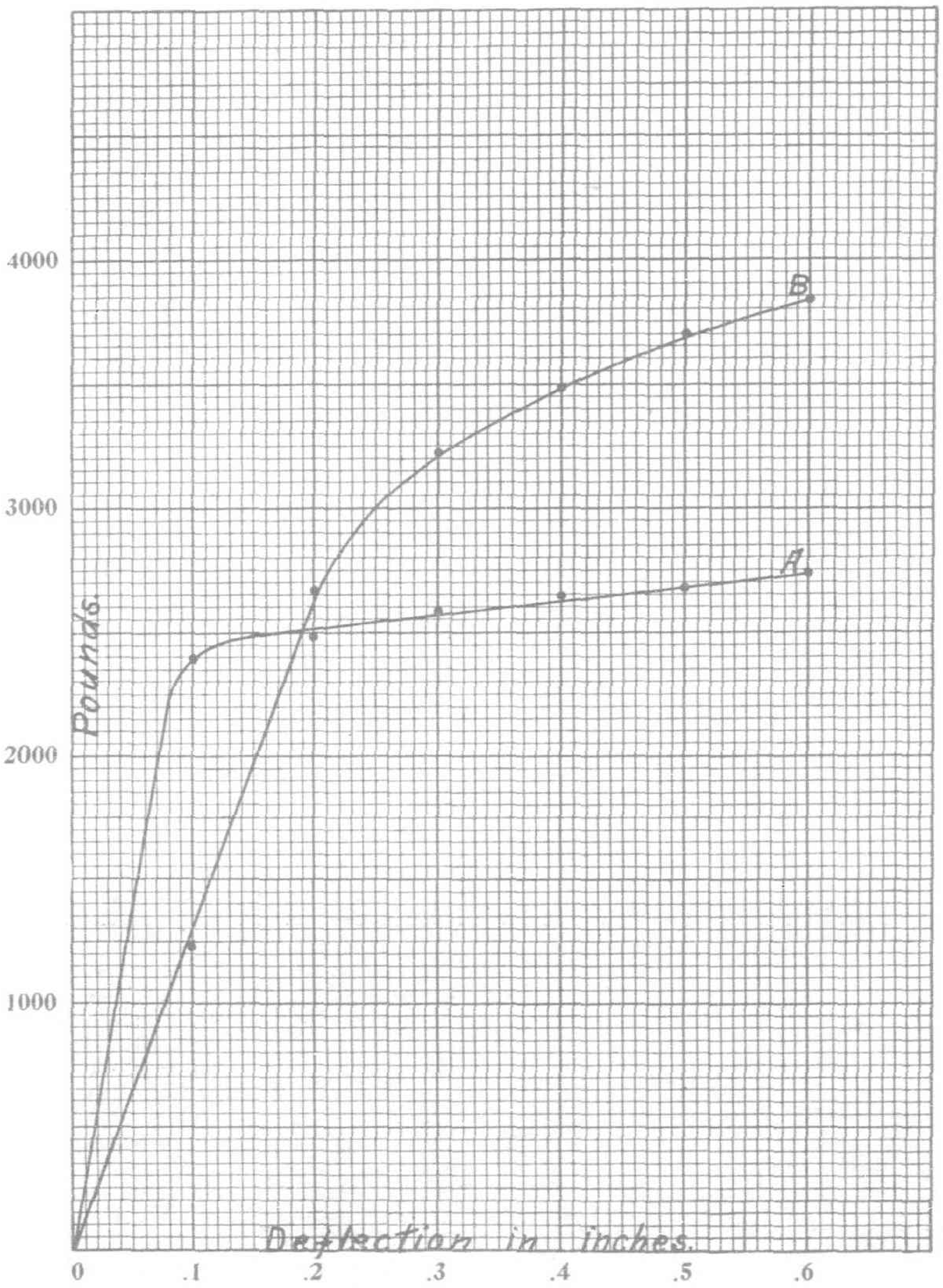
24″. The tree attains much larger sizes in other provinces. *Amuguis.*—Amuguis is a structural wood of medium quality, being fairly strong, brittle, moderately heavy and hard. Amuguis is reddish brown in color and is rather fine grained. Amuguis is used in ordinary construction and in cabinetwork. On a coastal plain in Mindoro the average diameter of 185 trees 16″ and over is 25″, and the average clear length of 10 trees is 33′. In Baler, Tayabas, the average diameter of all trees of Amuguis, on 81 acres, 8″ and over is 13″ and the maximum diameter is 31″. *Acle.*—The wood of Acle is moderately heavy and hard, quite durable, and seasons well. This is one of the most beautiful Philippine woods. It has a rich dark-brown color and is fine grained. It resembles English walnut and is usually given a walnut finish. When plain sawn it presents a large irregular figure, but when quarter sawn the grain appears finer. Acle is highly valued for fine furniture and cabinetmaking. Plain sawn lumber is preferable for large surfaces and quarter sawn for small surfaces and panels. This wood is considered as good as walnut for gunstocks, but has not yet been used commercially for that purpose. Acle is a tree with a short irregular bole. *Betis.*—A high-grade structural timber, being very hard, heavy, strong, and durable. It lasts well in the ground and is fairly resistant against the attack of sea worms (*teredo*). Betis is a light-brown to purplish color and is very fine grained. Betis is used in general high-grade construction, where strength and durability are essential. It is used in shipbuilding and for piles and posts. *Bansalaguin.*—A valuable structural timber, being very hard, heavy, strong, brittle, and durable. Large sizes of it check somewhat in seasoning and it is hard to saw. Bansalaguin has a dull reddish color and is very fine grained. Bansalaguin is a first-class construction timber and is used for posts, for shipbuilding, as tool handles, and in turnery. *Palo Maria.*—A good construction timber; is hard, moderately heavy, and fairly strong and durable. It is inclined to warp slightly. Palo Maria has a reddish color, is fine grained, and takes a beautiful finish. It has an irregular figure, which is caused by part of the fibers running perpendicular to the surface. Palo Maria is used in general construction, for masts, and for hubs and turnery. It is very valuable for fine furniture. *Batitinan.*—A structural timber of good quality, being hard, durable, and heavy. Batitinan is light yellow to olive green in color and has a fine and straight grain. Batitinan is used in general construction and for posts and sleepers. *Aranga.*—Very hard, heavy, strong, and durable. It is one of the most valuable woods in sea water, for it withstands well the action of the sea worm (*teredo*). It is usually clear and sound and seasons without difficulty. Aranga is light yellow in color and fine grained. Aranga is used as piling and in construction in sea water almost exclusively. It is, however, a very valuable timber for high-grade construction. *Banuyo.*—Moderately heavy and moderately hard, but is not very strong. It is easily worked. The wood of Banuyo is golden brown in color and has a fine grain similar to that of Acle. It is often finished in its natural color and sometimes stained a dark brown and given an Acle finish. Banuyo is used in making fine furniture and in cabinetwork. Its beauty is only beginning to be appreciated. It is used to some extent in light construction. *Balacbacan.*—Moderately heavy, very soft, and brittle. It seasons well and is easily worked. Balacbacan is reddish brown in color and coarse grained. Balacbacan is used in light or temporary construction and for inferior cabinetwork. In the Island of Negros the average diameter of 620 trees 16″ and over is 27″, and the average merchantable length of 6 trees is 69′. In the same stand, for the tree known as Mangachapuy (see below) measurement of 1,142 trees 16″ and over shows the average diameter to be 34″, and the merchantable length (average of 23 trees) is 72′. *Mayapis.*—A light, soft wood and is not durable. Mayapis is white and gray in color and coarse grained. Mayapis is used in light or temporary construction. In Baler, Tayabas, measurements of all trees 8″ and over in diameter, on 31 acres, show that Mayapis has an average diameter of 26″, a maximum diameter of 75″, and an average merchantable length of 68′. *Malugay*—The most important property of Malugay is toughness, a quality quite uncommon among Philippine woods. It bends well when steamed, is fairly strong and stiff, and has long fibers. It is moderately heavy and moderately hard, but easily worked. It is usually free from defects and shrinks considerably while seasoning, but does not check badly. Malugay ranges in color from reddish to white and is fine grained. Malugay is used for ribs and planking for small boats; in interior trim; for carbinetwork, and for general construction. This wood has only recently been introduced into the Manila market and at present is not used extensively. It is an excellent wood in many respects and will undoubtedly come into greater favor. *Sasalit*—A very hard, heavy, close-grained, and durable wood. Small knots and checks are quite common. It has the color of Molave—that is, a pale-yellow



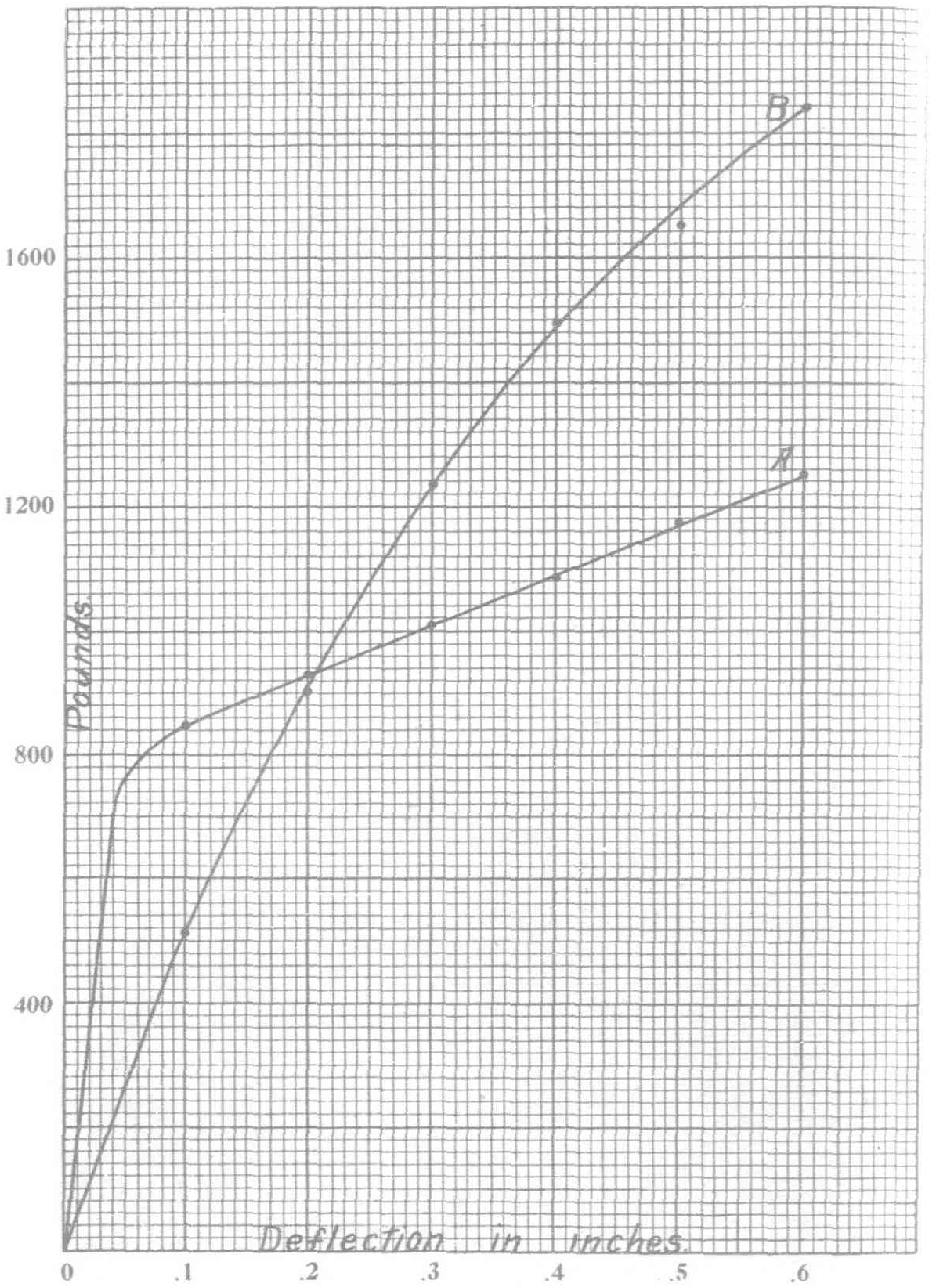
RESSION ACROSS THE GRAIN—YACAL GROWN IN AMBOS CAMARINES ESTS; AVERAGE PERCENTAGE OF MOISTURE, 28.6; AVERAGE SPECIFIC GRAVITY (DRY), 0.85



COMPRESSION ACROSS THE GRAIN—TANGUILE; LOCALITY UNKNOWN—7 TESTS; AVERAGE PERCENTAGE OF MOISTURE, 36.7; AVERAGE SPECIFIC GRAVITY (DRY), 0.531



COMPRESSION ACROSS THE GRAIN—IPIL GROWN IN AMBOS CAMARINES—6 TESTS; AVERAGE PERCENTAGE OF MOISTURE, 43.6; AVERAGE SPECIFIC GRAVITY (DRY), 0.755



COMPRESSION ACROSS THE GRAIN—DUNGON GROWN IN AMBOS CAMARINES—9 TESTS; AVERAGE PERCENTAGE OF MOISTURE, 25 TO 35; AVERAGE SPECIFIC GRAVITY, NOT DETERMINED

color—and is fine grained. Sasalit is used for posts, general house construction, and is considered as good as Molave for these purposes. In the Island of Negros the average diameter of 173 trees 12″ and over is 15″. In Baler, Tayabas, the average of all trees 8″ and over, on 81 acres, is 12″, the maximum diameter is 38″, and the clear length is 33′. *Liusin.*—A very hard, heavy, strong, and durable wood. It withstands well the action of the sea worm (*teredo*). Liusin is white and reddish in color, and is fine grained. Liusin is used in piling, for wharf construction, and for shipbuilding. It is considered one of the best woods for construction exposed to sea water. *Lumbayao.*—A soft and moderately heavy wood of medium quality. It seasons well and is usually free from defects. Lumbayao has a reddish-brown color and is coarse grained. Lumbayao is used in general construction. This wood is marketed in Zamboanga, Iloilo, and Cebu, but is not brought to Manila.

PHILIPPINE SAWMILLS, LUMBER MARKET AND PRICES.—Manila is the principal lumber market of the Philippines. Here are located five of the most important mills. Timber is being shipped to them from all parts of the Islands. Three of these mills are equipped with heavy band saws and other modern machinery. The other mills are equipped with vertical gang and circular saws. The combined sawing capacity of the five mills is about 100,000 board feet per day. One mill has a capacity of 30,000 board feet, two of 20,000 board feet, and two of 15,000 board feet per day.

During the early operations of the mills in Manila, they had to contend with numerous difficulties; Filipino labor was unreliable; many of the hardwoods were difficult to saw and it was impossible to secure a sufficient supply of logs from the provinces with regularity. Conditions have improved, however, during the past two years, and the mills are now operating in a very satisfactory manner. They now saw all commercial woods without difficulty and are depending more and more upon their own cuttings to supply logs to meet their requirements. With proper training, Filipinos are found to be apt in handling machinery. Two of the mills have recently been running at night to fill orders.

Some confusion exists in the market regarding the identity of a few of the leading commercial woods. This is especially true of Lauan. At least six different woods are now being marketed under that name. From the commercial standpoint this is not important, however, as all of these woods resemble the true Lauan (*Shorea contorta*) closely and are of about the same quality. There are several different kinds of wood being sold for Apitong, and occasionally Apitong is sold for Guijo. Lauan, Apitong, and Guijo are used to a larger extent than any other fifteen native woods.

Logs are bought and sold by the Spanish cubic foot. One Spanish cubic foot equals 0.765 of an English cubic foot. Lumber is bought and sold by the thousand English board feet.

In sawing the average-sized logs that are brought into the market, between 5 and 6½ board feet are obtained from 1 Spanish cubic foot, but in the large-sized logs sometimes as high as 8 board feet are cut from 1 Spanish cubic foot.

Until quite recently it has been practically impossible to obtain well-seasoned lumber in the market. The mills have been accustomed to sawing to order, consequently lumber was seldom in the yards a sufficient length of time to become seasoned. There were no facilities for kiln drying lumber in large quantities. Two small kilns were erected several years ago, but they were of small capacity and have not been used extensively. One of the leading mills has recently installed a kiln of about 50,000 board feet capacity which is operating very satisfactorily. This kiln is capable of drying 100,000 board feet or more of native lumber per month, the amount depending upon the texture and thickness of the lumber. This concern is now using kiln-dried native lumber in its cabinet factory and is preparing to kiln dry Oregon Pine and California Redwood for use in its planing mill.

A considerable amount of imported lumber is still used in the Islands. Most of this is Oregon Pine and California Redwood. During the period from July 1st, 1904, to June 30th, 1905, 29,679,644 board feet of lumber and timber, and 9,261 pieces of timber (dimensions not known) were imported. During the same period, 139,148.77 cubic meters of native timber were cut. If this were all sawn into lumber, it would make about 40,000,000 board feet.

The price of logs fluctuates from day to day. The following table gives the Manila market prices:—

Manila Market Prices.

[Philippine currency; ₱2=$1 gold.]

Kind of wood.	Logs per Spanish cubic foot.	Sawing per 1,000 English board feet.	Lumber per 1,000 English board feet.
Lauan	₱0.30-0.35	₱13.00-15.00	₱ 70.00- 90 00
Apitong	.35- .37	16 00-18.00	90.00-115.00
Guijo	.50- .65	16.00-18 00	98.00-140.00
Molave	.80- .90	21.00-23.00	215 00-300.00
Yacal	.65-1.00	21 00-23 00	160.00-200 00
Yellow Narra	.70- .80	16.00-23 00	225 00-275.00
Red Narra	.75-1.00	16.00-23.00	250 00-300.00
Tanguile	.33- .45	13 00-18 00	95.00-120 00
Sacat	.40- .75	15.00-18.00	100.00 150.00
Ipil	.76- .85	21 00-23.00	180 00-225.00
Dungon	.80- .90	38.00 40 00	220.00-300.00
Supa	.65- .70	21.00-23.00	140 00-220 00
Balacat	.40	18.00	100.00
Macaasin	.40- .75	15.00-18.00	110.00-150 00
Calantas	.65-1.20	13.00-15.00	180.00-200 00
Tindalo	.78-1.00	21 00-23.00	250 00-300.00
Amuguis	.40- .75	18 00-21.00	110.00-150.00
Acle	.85-1.20	16.00-23 00	280 00-350.00
Betis	.70-1.00	38.00-40 00	250 00-300 00
Bansalaguin	.45- .85	23.00	150 00-260 00
Palo Maria	.75- .80	18.00	175.00-185.00
Batitinan	.65- .75	21.00-23.00	150 00-280 00
Aranga	.50- .75	21.00-23.00	150 00-160.00
Banuyo	.55- .75	16.00-18.00	140 00-220.00
Malugay	.60- .65	16.00-23.00	95,00-130 00
Balacbacan	.35	13.00-18.00	70.00- 90 00
Mayapis	.35	15.00	90 00

Aside from the logging which is carried on to supply the Manila mills, there is some logging in connection with mills located in the provinces.

The operations of one company in Negros Occidental are probably more extensive than those of any other company in the provinces Their mill has a capacity of about 20,000 board feet per day, but the daily cut is less than 10,000 board feet. The trees known by the Visayan names of Balacbacan, Mangachapuy, and Almon are being cut principally; the first two are sold in Iloilo and Manila as Red Lauan or Balacbacan. Almon has the market name of White Lauan. This company has recently purchased a narrow-gauge railway for use in logging and contemplates putting in a new mill, with a much larger capacity, in the near future. Another company has a mill located on the Island of Basilan, which is cutting about 6,000 board feet lumber per day. This lumber is marketed in Zamboanga, Iloilo, and Cebu. The Zamboanga prices quoted by this company are as follows:—

	Per 1,000 board feet.
Lumbayao	₱72.00
Guijo	80.00
Calantas	80.00
Yacal	140 00
Camagon	300 00
Tindalo	180 00
Ipil	180.00
Lauan	50.00
Narra	200.00

Planing, ₱7 extra per 1,000 board feet.

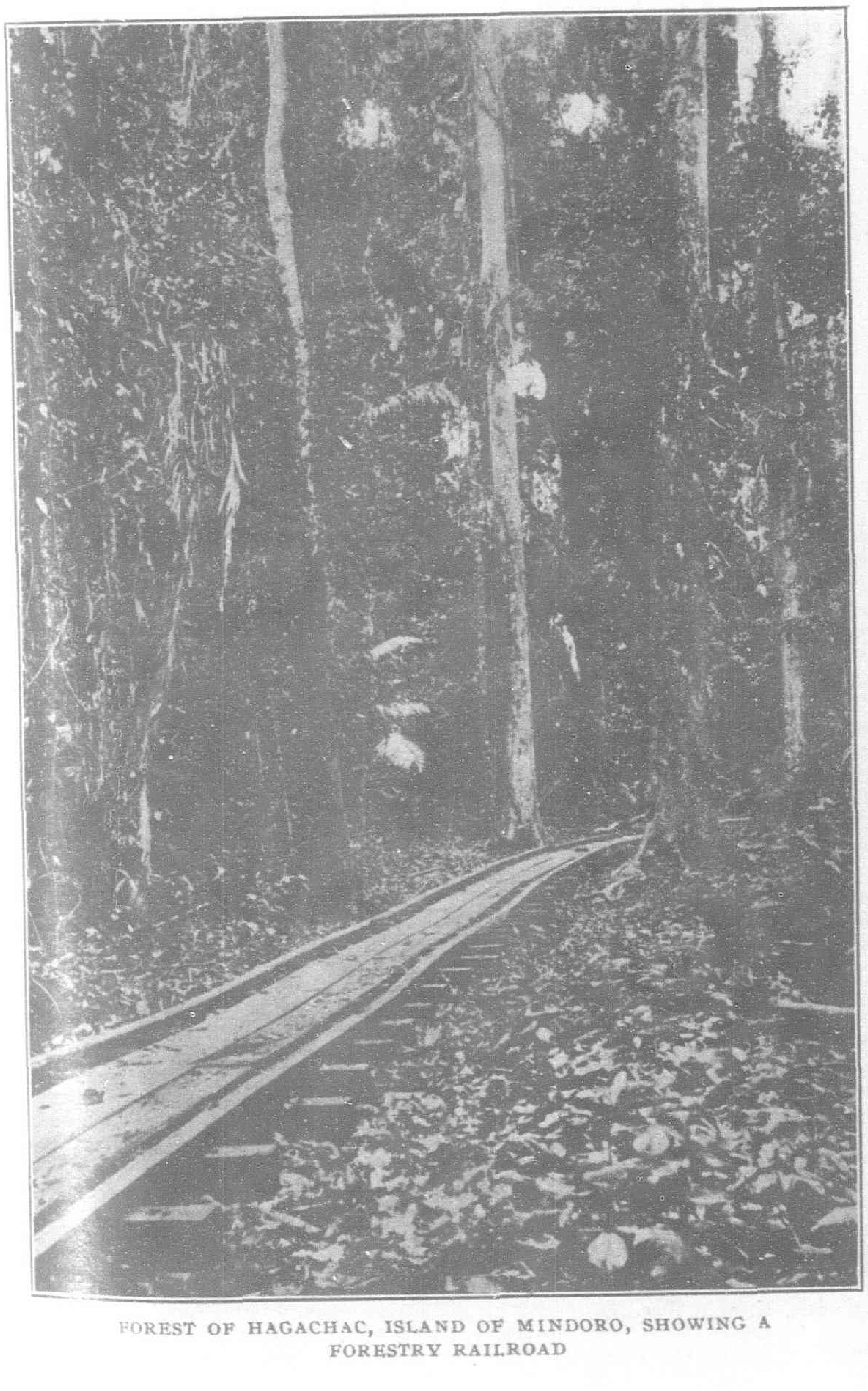
Another company, a branch of a Manila milling company, has recently installed in Mindoro a circular-saw mill, with a capacity of 5,000 to 10,000 board feet per day. In the near future this company will have the mill operating at full capacity and will ship lumber to Manila.

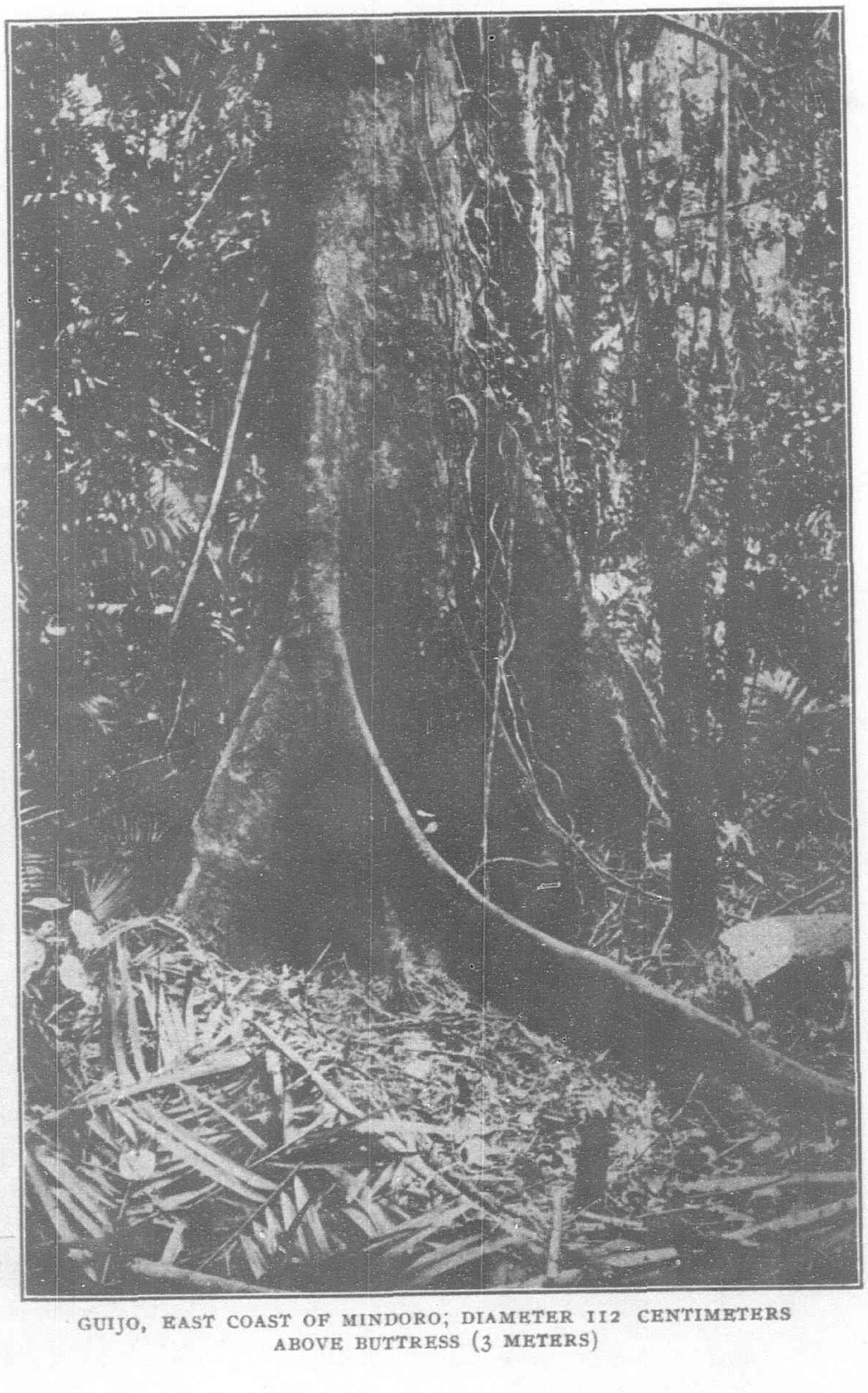
Near Baguio, Benguet, there is a mill for sawing Benguet pine, which sells in Baguio and vicinity for ₱85 to ₱95 per 1,000 board feet. The maximum capacity of the mill is 3,000 board feet per day, and the average daily cut is 2,000 board feet. In the near future, this company will have a new sawmill in operation in the same locality.

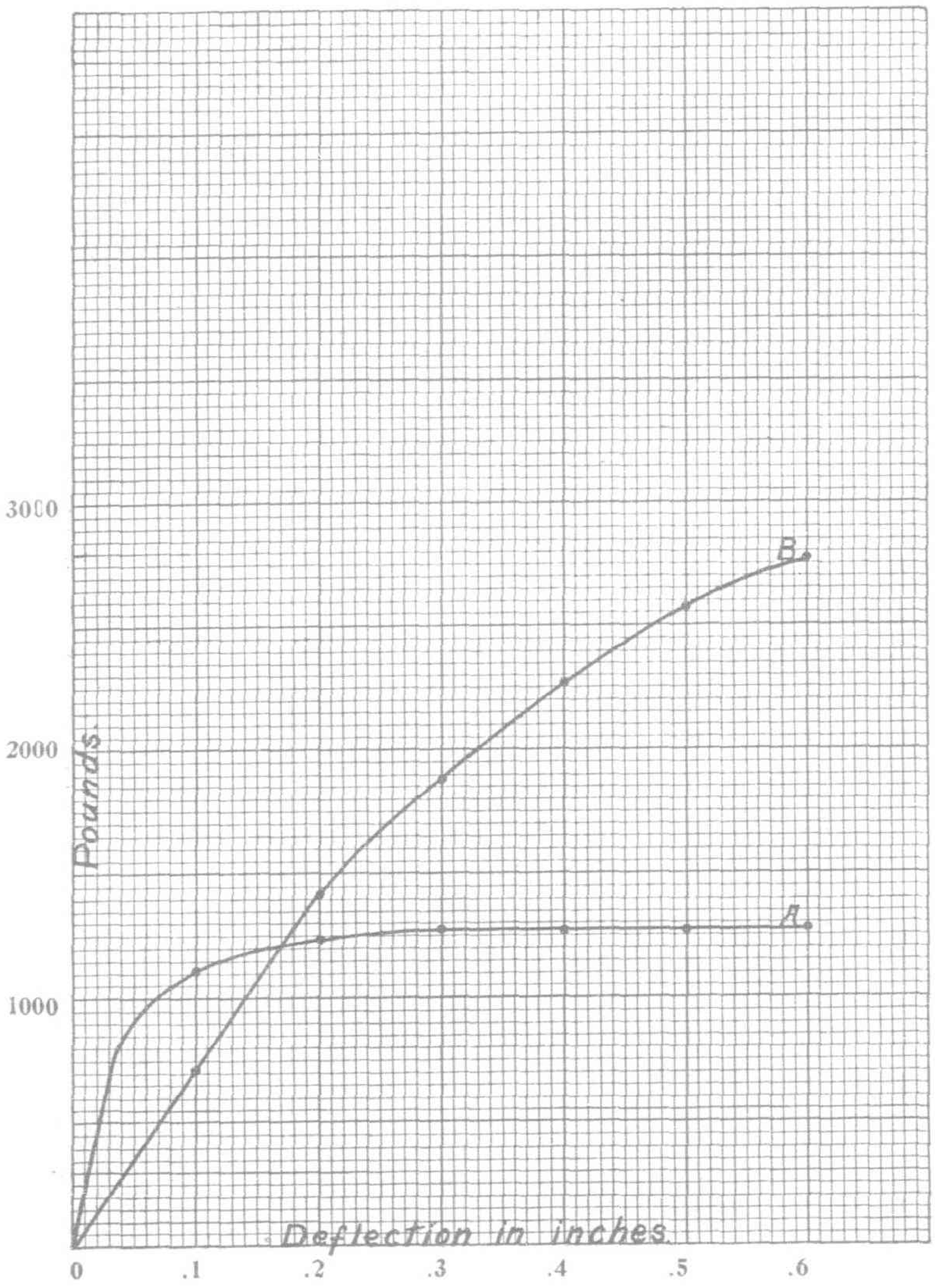
A small mill has recently been installed at Gattaran, Cagayan, which supplies Aparri and the towns up the Cagayan River with lumber. This mill charges ₱0.80 per English cubic foot for first-group timber in the log, and ₱20 per 1,000 board feet for sawing.

About 2,500 board feet per day is the capacity of a mill which is cutting Agoho (*Casuarina equisetifolia* Forst.) almost exclusively at San Antonio, in the Province of Tarlac. This is put on the market at Manila for ₱100 per 1,000 board feet.

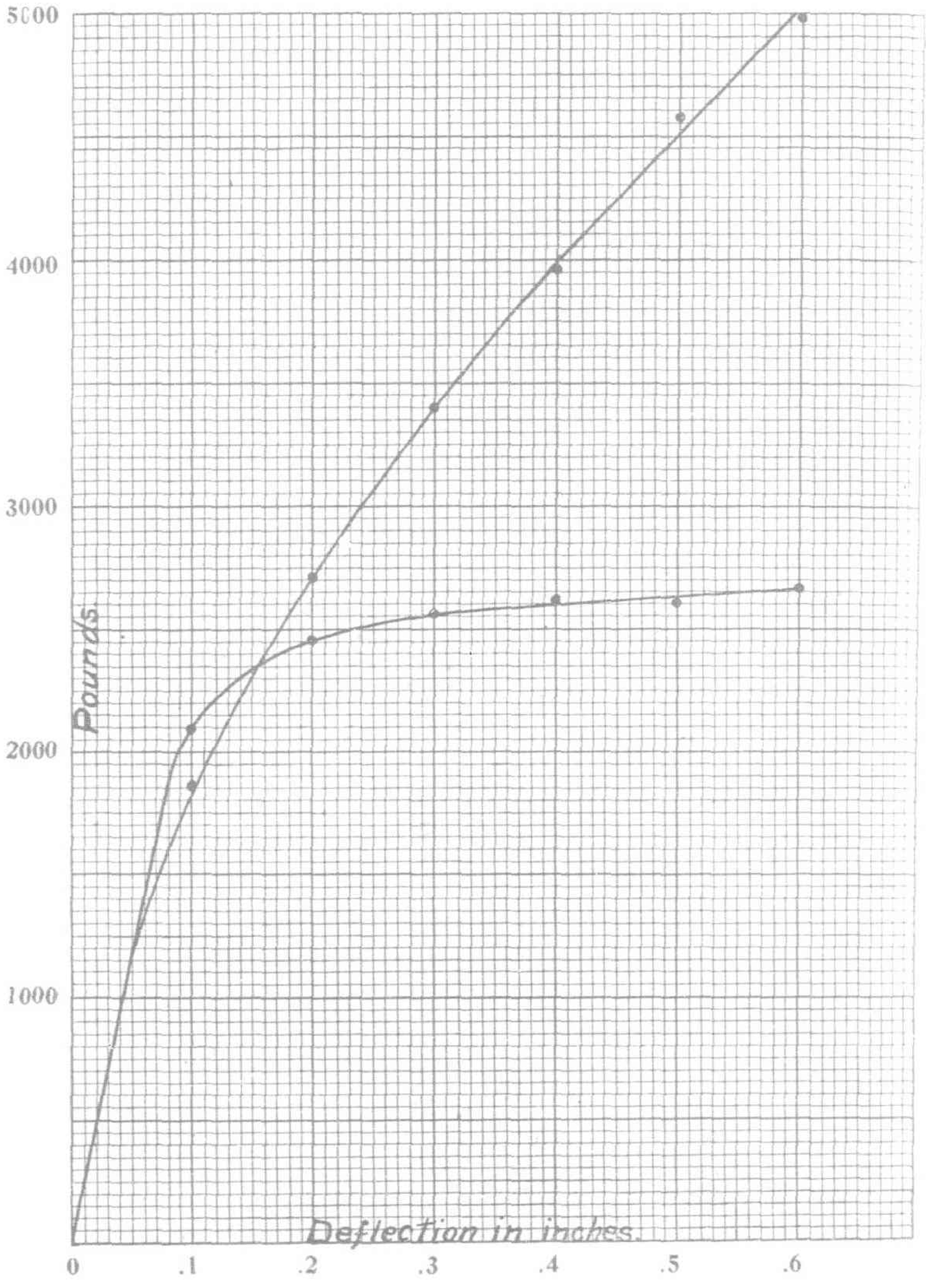
SHANGHAI-NANKIN RAILWAY.—It is now confidently expected that the Shanghai and Nankin Railway will be completed through to the latter city before the end of the current year. According to the original plans the railroad will not enter the City of Nankin itself, but is to have one station just outside the northeast city gate and another on the bank between Hsia-kuan and the mouth of the Nankin cut off. There is some talk of a tramway from the river station, which will pass through Hsia-kuan, follow the city wall on the outside, and end at the Han-hsi Gate. This line would be principally for the conveyance of passengers to and from the railway station and river steamer landings, but it would not enter the city. While the Chinese are certainly progressing and changing in many ways they still stick to some old customs and observances which, to say the least, cause them much inconvenience. They seem to have an innate dread of permitting any new opening to be made in the city walls, and consequently neither railways nor trams can enter.


FOREST OF HAGACHAC, ISLAND OF MINDORO, SHOWING A FORESTRY RAILROAD


GUIJO, EAST COAST OF MINDORO; DIAMETER 112 CENTIMETERS ABOVE BUTTRESS (3 METERS)



COMPRESSION ACROSS THE GRAIN—AMUGUIS GROWNIN MINDORO—10 TESTS; AVERAGE PERCENTAGE OF MOISTURE, 5.19; AVERAGE SPECIFIC GRAVITY), 0.681



COMPRESSION ACROSS THE GRAIN—ARANGA GROWN IN AMBOS CAMARINES—8 TESTS; AVERAGE PERCENTAGE OF MOISTURE 25.6; AVERAGE SPECIFIC GRAVITY (DRY), 0 806

BIG SUGAR MILL FOR JAPAN

Judging from all present indications, says a Honolulu exchange of December 15th, the Honolulu Iron Works is about to score another triumph in the Far East; only this time it will probably be a greater one than before. Manager Carl Hedemann of the Iron Works has left for Japan in connection with this matter.

For some time past, the Iron Works has been in correspondence with a large Japanese company, which has extensive sugar interests on the Island of Formosa. This concern intends to erect a big mill, and the Iron Works some time ago sent over its estimates on the matter. A couple of days ago a hurry call was sent from the company asking that Manager Hedemann come to Japan as soon as possible. This indicates that the Japanese have decided to have the Iron Works take the contract for erecting their mill, and that they want to close the deal and get the work started as soon as possible.

The mill which this company intends to build will be a very large one, of about the same size as that at Waialua. The Iron Works has already built one mill in Formosa, but that was a smaller affair, of about the size of that of the Waiakea Mill Company, near Hilo.

Besides the matter referred to above, the Iron Works have for some time past been negotiating with a large sugar refining company, also in Japan, which also intends establishing a large plant. This affair will also be attended to by Hedemann while he is in Japan. Although the Iron Works is at present having an extremely busy season, and the absence of Superintendent Dyer made the staff short handed, the matters mentioned were considered to be of considerable importance and to warrant Hedemann making the journey. He will be absent only a comparatively short time expecting to return in the middle of January.

The success which the Honolulu Iron Works is meeting in placing its plants in the Far East as well as elsewhere, can be nothing but extremely flattering. Furthermore, it is of no mean importance to the community at large, as the making of these enormous quantities of machinery means a good bit of money in the pockets of the laboring man.

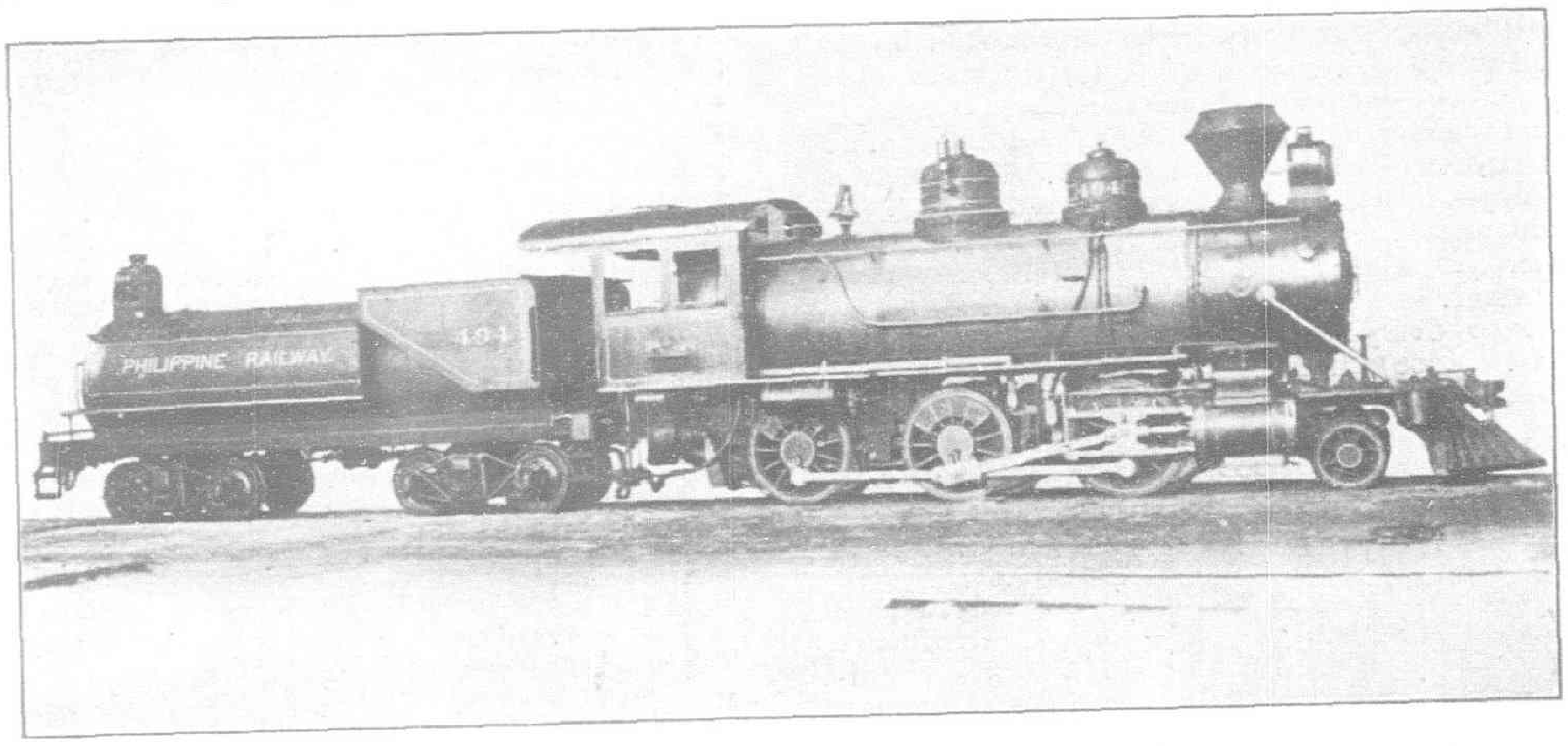
While it is considered that the presence of so many Japanese in this country, not a few of whom are well able to judge about mills and sugar machinery, may have something to do with the success which the Iron Works has met in Japan, it is also an assured fact that the intrinsic merits of the machinery turned out by that concern is the main cause thereof, as the Japanese sugar men have solicited bids and estimates not only from the mainland but also from Europe, and it has been after a comparison with these that Honolulu has carried off the prize as being able to do the most satisfactory work.

SINGAPORE AND KRANJI RAILWAY

The total earnings in 1905, showed increase of $7,486 over 1904. An increase of 23,225 passengers and 24,324 piculs of goods over 1904 is shown in 1905. On season tickets there is an increase of 90. One early and one late train have been added to the service for the convenience of season ticket-holders and others. These trains do not pay but they will be given a fair trial before they are withdrawn. Considering that the railway has been open more than three years, there has been very little building in Bukit Timah Road and adjacent localities. The capital account to December 31st, 1905, was $1,933,510.36. The net earnings for the year were $68,744.38, equal to a dividend of 3.56 per cent. The total revenue from all sources amounted to $203,031.40. The net earnings per train mile were 63 cents. The working expenses for the year amounted to $134,287.02. The proportion of working expenses to gross receipts was 66.14 per cent. No heavy repairs were charged to revenue during 1905. There was a great deal of trouble with all the locomotive boilers and all of them have been overhauled. They were all pitted more or less and the cause is put down to the water, but the matter is not yet satisfactorily settled. One bogie first-class, one bogie second-class and one bogie compo brake van were added to the rolling stock, and 31 carriages and wagons were repaired and painted during the year. There were three engine failures and six cases of hot axles during the year. The two ferry steamers have worked satisfactorily but considerable repairs were necessary to one of the boilers. Ferry mileage 7,832; engine mileage 113,726. There was only one derailment during the year, that of a goods truck in Singapore Yard.

PHILIPPINE RAILWAY ROLLING STOCK

A consignment of four mogul locomotives and several 30-ton Rodger ballast cars, for construction work on the new railways on the Islands of Panay, Cebu and Negros, Philippine Archipelago, has been unloaded from a ship at Iloilo. This rolling stock came from the United States as a part of a cargo of railroad materials, and is being set up for use as required. The locomotives are somewhat heavier than the nature of the work they will be called upon to do demands and the future orders for engines will call for lighter types. All of the rolling stock now on the ground was ordered by Messrs. J. G. White & Co., Inc., of New York, the engineering contractors for the Philippine Railway Company.



MOGUL LOCOMOTIVE FOR THE PHILIPPINE RAILWAY

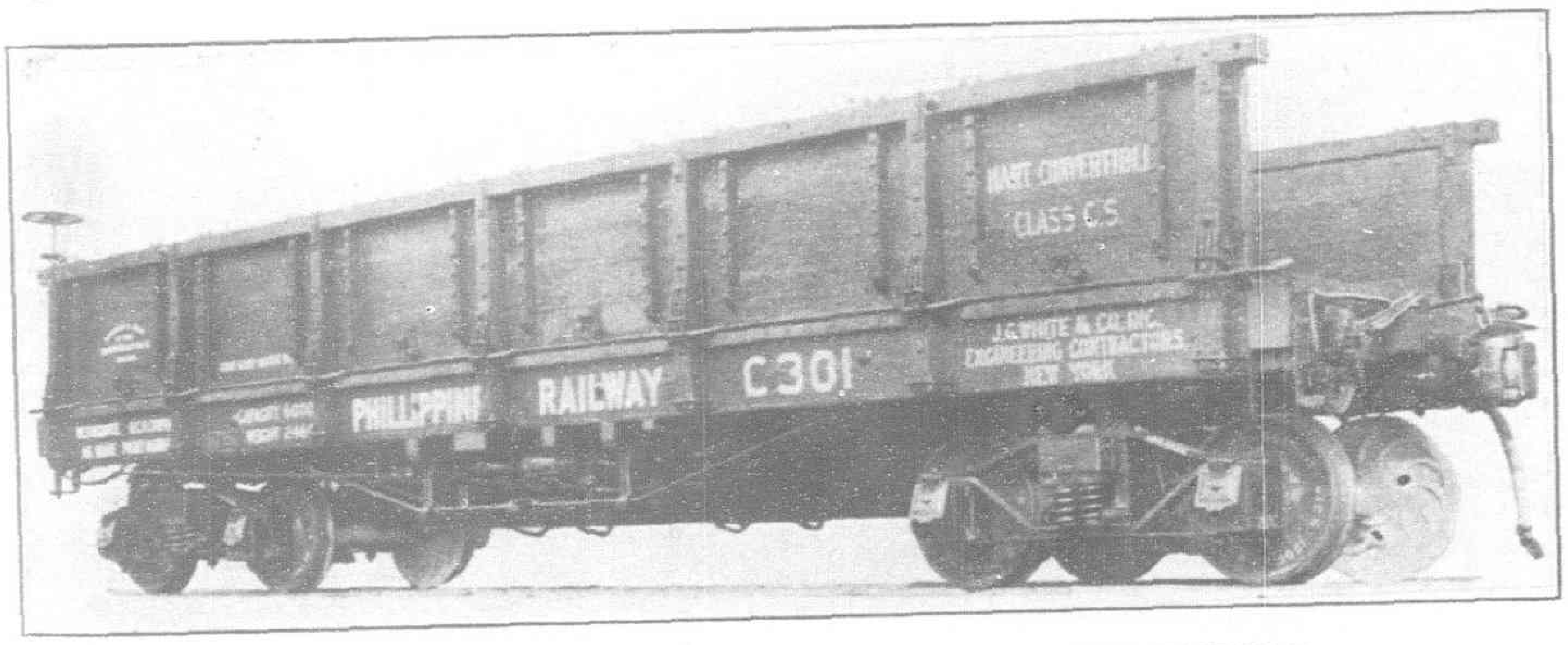
The mogul (2-6-0) locomotives were built by the Baldwin Locomotive Works, Philadelphia. They are narrow gauge (3′ 6″). The cylinders are 17×26″, driving wheels 50″, and with a working steam pressure of 180 lbs. per square inch the tractive power effort of the engine is 21,000 lbs. The driving-wheel base is 12′ and the total wheel base of the engine is 19′ 4″. The weight on drivers is 84,000 lbs., and the total weight of engine and tender ready for service 183,000 lbs. The boiler is 60″ in diameter, with a total heating surface of 1,322 square feet. The grate area is 19 square feet, giving a ratio of heating surface to grate area 69. The engine and tender are fitted with estinghouse airbrakes and M. C. B. automatic uplers, and they are arranged to work on rves of from 15 to 20 degrees. The valves the Richardson balanced type and are rated by the regular Stephenson link motion. grate and stack are designed to burn Phil- ine lignite coal. A sample of the coal from Caridad mines on the Island of Cebu gave following analysis:—Fixed carbon, 54 per ; volatile matter, 35 per cent; moisture, 9 cent; ash, 2 per cent. The stack used for fuel is somewhat similar to the old diamond which was used so successfully with the tes west of the Missouri River, in the ed States. The analysis shows that the ppine lignite is of a superior grade, as it has such a large proportion of fixed carbon. Ordinary lignites have much less than 50 per cent fixed carbon and the Philippine lignite must be classed as low-grade bituminous coal. A very efficient spark arrester is necessary on account of the numerous villages along the lines, as the native houses are for the most part built of the highly inflammable bamboo and nipa.

These locomotives are intended primarily for mixed passenger and freight traffic, and it is estimated that they will haul a gross load of 500 tons up a straight grade of 1½ per cent. The principal dimensions are given in tabulated form below:—

Gauge	3′ 6″
Weight (total)	98,000 lbs.
Weight on drivers (approximate)	84,000 lbs.
Diameter of drivers	50″
Cylinders	17×24
Boiler (diameter)	60″
Boiler (number of tubes)	220
Boiler (diameter of tubes)	2″
Boiler (length of tubes)	10′ 6¼″
Firebox (length)	95″
Firebox (width)	29″
Grate (area)	19.13 sq. ft.

Tender.

Tank (type)	Vanderbilt cylindrical.
Capacity (water)	40,000 galls.
Capacity (coal)	8 tons.
Wheels (diameter)	33″



30-TON RODGER BALLAST CAR FOR THE PHILIPPINE RAILWAY

Ballast Cars.—The ballast cars were built by the American Car and Equipment Company, Chicago, at its Michigan Department Works, Detroit. Their equipment conforms to the specifications and it is believed will be in every way satisfactory, the journal boxes of malleable iron corresponding to the M. C. B. standards in general dimensions. The axles are of steel and underwent a thorough physical and chemical test at the works of the Carnegie Steel Company, which showed them to be satisfactory and suitable for the purposes intended. The castiron wheels were made of particularly good material, the weight of each being 500 lbs. They were forced on axles at pressures varying between 30 and 45 tons. The brakeheads and shoes correspond to the M. C. B. standards, and the airbrake and its details are well designed and conform to the M. C. B. proportions. The braking power is 16,000 lbs. The weight of the car empty is 24,600 lbs., which gives a braking power of about 65 per cent of the light weight. There is ample clearance for passing curves of 20 degrees, and the height of the coupler is 34″ from the rail. Grabirons and steps are located in accordance with the legal requirements in America, and the airbrake hose is of the Peerless Perfected make. The clearance width of the car is less than 9′. The brake cylinders are 6×8″ and the travel of the brake piston with the car standing in the shops was 4″. The cars are of the convertible type and can be worked with or without the sides and hopper, the doors of which latter are operated by means of levers at the end of the car. The illustration herewith shows the car with the side attachments. In this connection it might be noted that the spelling of the word *Philippine* has been corrected. These cars are said to be the best and most convenient for construction purposes manufactured in the United States.

CHINESE LIGHTHOUSE SERVICE

The extension of the Chinese lighthouse service is noted by a Shanghai correspondent of the London *Times*.

Among the many and great services rendered to China by the Imperial Maritime Customs Administration, not the least has been the provision of a first-class system of lights and other aids to navigation on the coast and navigable rivers from Hainan and Formosa in the south to Newchwang in the north. The list of the new lights in hand or projected for immediate execution is as follows:—A sixth-order light for a rock near the Bogue Forts, Canton River; a large steel gaslighted lightship for the Yangtsze; a fourth-order group-flashing light for Tungting Island (Chusan Islands); a first-order group-flashing light on Chelang Point, and two fourth-order group-flashing lights and one fourth-order occulting light for the channel between Fuchau and Wenchau. The coast and rivers in China are divided into 17 districts, in each of which the lights are officially under the local commissioner of customs. The Shanghai and Ningpo districts are controlled by the coast inspector's office at Shanghai; south of Ningpo by an inspector stationed at Amoy; while Shan-tung and the Gulf of Pechili are worked from Chifu and Tientsin. Inspection and victualing work are done by steam tenders and by the revenue cruiser fleet. Sites for new lights are chosen by the engineer in chief and coast inspector in consultation, and the estimate submitted to the inspector-general. Local expenditure is defrayed by the commissioner of the port concerned, while contracts for lanterns, etc., required from abroad are put up for tender in London by the customs secretary residing there. Most of the lanterns and optical apparatus have been supplied by Birmingham and Paris firms. There are practically no fixed lights on the coast. All the new revolving lights are floated on mercury and provided with incandescent petroleum burners.

REDWOOD RAILWAY TIES

In a letter to the California-Manila Lumber Commercial Company, of Manila, which imports extensively California redwood, the Superintendent of Construction for Messrs. J. G. White & Co., Inc., at Manila, gives testimony as to the merits of redwood for railway ties or sleepers. Writing for the Superintendent of Construction, under date of December 6th, 1906, Mr. W. E. Conklin, Assistant Superintendent of Construction, says:—

"GENTLEMEN:—In reply to your request for information as to our experience with the redwood ties furnished us by the California-Manila Lumber Commercial Company, we beg to inform you that many of these ties have been in the track (Manila electric railway system) for about two years, and in all portions of the track dug up for repairs no signs of anay or rot have appeared. The ties still seem to be in very good condition. These ties, of course, are not as satisfactory as hardwood ties for curves unless tie-plates are used, which have not been used here."

RECONSTRUCTION OF MANILA RAILWAY COMPANY

The directors of the Manila Railway Company have announced from their London office that negotiations for the reconstruction of the company necessary to carry out the terms of settlement with the United States Government, set forth in the circular of August 3d last, sent to the shareholders, are concluded, and are contained in a plan of reconstruction issued to the shareholders with the report for the year ended December 31st, 1905. The plan has received the careful attention of the directors, and has been adopted by the shareholders.

Claim Against United States.—The directors recall that after the Spanish-American War the company presented a claim for the amount due under the guarantee given with the Spanish concession; but liability was denied by the Washington Government. After the return of the railway to the company there were presented to the United States Government claims for use and for damages. In June, 1905, the Philippine Government invited tenders from United States or Philippine Corporations or citizens for the construction of various lines on the Island of Luzon, as well as on other Philippine islands. Two members of the Board of Directors proceeded at once to Washington to take up again with the British Ambassador the negotiations for damages. After much consultation Messrs. Speyer & Co., of New York, with a view to coöperating with the company, and at the same time, as far as possible, to protect the shareholders' interests, presented a bid for the construction of various lines on the Island of Luzon, which were considered to be profitable commercial enterprises if worked in connection with the railroads owned by the company. None of the bids presented were accepted; but, as the result of subsequent negotiations, an award was made to Messrs. Speyer & Co. of a concession for these lines, which have now been assigned to a New Jersey Company organized by them, known as the Manila Railroad Company. The concession which has been granted to the American company is a perpetual concession, qualified only by the not unusual condition that it is subject to amendment, alteration or repeal by the Congress of the United States. It authorizes and requires the construction of 450 miles of railroad in the Island of Luzon, which are reported by Mr. Horace L. Higgins, general manager of the Manila Railway Company, Ltd., to be likely to be remunerative, and provides that the favorable rates of taxation prescribed in respect to the new lines shall apply to the existing lines when owned or operated by the American company, and that the concession or franchise shall appertain to the English company's lines when it shall have fully discharged all claims against the United States and the Philippine Government. Mr. Higgins, who has been closely associated with the Manila Railway since its formation, has agreed to take the office of President and General Manager of the American company.

A Satisfactory Position.—In the opinion of the directors the position thus brought about is thoroughly satisfactory. They have, therefore, with the assistance of Messrs. Speyer & Co., in New York, and Messrs. Speyer Brothers, in London, very carefully considered how to effect the transfer of the property to the American company and the construction of the new lines, at the same time ensuring that practically the entire net revenue of both the present system and the new lines shall be retained. A new English company will be formed called the Manila Railway Company (1906), Limited, referred to herein as "the new company," which will act as a holding or securities company. As part of the plan, the following agreements will be made:—(1) An agreement with the American company under which the English company will sell its undertakings in consideration of an agreed amount of the American company's securities; (2) an agreement with the new company under which the old company will nominate the new company to receive such securities in consideration of the new company's issuing to the old company an agreed amount thereof; (3) an agreement between the new company and American company for purchase by the new company of bonds and shares of the American company to be issued to obtain money for construction of new lines and other corporate purposes. Under the provisions of the Act of Congress applying to corporations doing business in the Philippine Islands, bonds and shares of the American company cannot be issued except in exchange for actual cash or for property at a fair valuation equal to the par value of the bonds or shares so issued.

The effect of the arrangement will be that there will be vested in the new company, as a holding company, practically all the bonds and shares issued by the American company. These will be vested by the new company in trustees, and against them will be issued the shares and securities of the new company, the prescribed portion of which will be offered to the shareholders in exchange for their existing holdings. The securities of the new company will thus have a charge on the entire net revenue, not only of the 208 miles of the present system, but of the further 420 miles to be built under the new concessions.

New Company.—The Manila Railway Company (1906), Limited, will have an authorized capital of £4,000,000, divided into 200,000 5 per cent non-cumulative preference shares of £10 each and 200,000 ordinary shares of £10 each. There will be a present issue in 4 per cent "A" debenture bonds of £1,600,000 and in 4 per cent "B" debenture bonds of £1,730.000. Power will be reserved in the trust deed that further amounts of each class of debenture bonds may be created and issued for the acquisition of securities issued by the American company for the construction or acquisition of new mileage or other capital purposes, provided that the total amount of bonds to be issued for the construction or acquisition of new mileage shall not exceed the rate of £5,000 of each class per mile, and that for other capital purposes the amount to be issued shall not exceed £50,000 *per annum* of each class. It is proposed to deal wth the securities and shares of the new company as follows:—Four per cent "A" debenture bonds: In exchange for the securities of the present company, £1,257,200; issued to provide funds for the requirements of the plan, £342,800; reserved for future construction and equipment, £1,400,000; total £3,000,000. Four per cent "B" debenture bonds: In partial exchange for the securities of the present company, £730,000; issued to provide funds for the requirements of the plan, £1,000,000; reserved for future construction and equipment £1,270,000; total, £3,000,000. Preference shares: In exchange for the shares and securities of the present company, £1,180,000; issued to provide funds for the requirements of the plan, £820,000; total, £2,000,000. Ordinary shares: In exchange for the shares of the present company, £399,270; reserve for new company, £1,600,730; total, £2,000,000.

The interest charges on the £1,600,000 "A" debenture bonds and £730,000 "B" debenture bonds will amount to £93,200, thus reducing the annual interest charges by about £15,000. Mr. Higgins estimates that the net income of the present system of 208 miles, having regard to the increased traffic, which should be brought as each connecting branch of the new system is opened, will be £116,000 for 1906, and will by 1912 have increased to £153,100. It is estimated that the construction of the 420 miles of new railroad will cost approximately £3,100,000, for which the issue of the securities reserved for this should fully provide, and that construction should be completed in 1911. Mr. Higgins estimates that the yearly net earnings of the sections, beginning with 1907, should be as follows: £4,200, £29,300, £66,900, £112,200, £135,800, £155,000. The total estimated net revenue of the 628 miles when completed and in operation will be £308,100.

Terms of Exchange.—The securities to be received in exchange for each principal sum of £100 existing securities are as follows: For 5 per cent first mortgage stock, £112 new 4 per cent "A" debenture bonds and16s.8d. for accrued interest to December 31st, 1906; for 6 per cent prior lien bonds, Series "A," £120 new 4 per cent "A" debenture bonds and £3 accrued interest; for 6 per cent prior lien bonds Series "B" £115 new 4 per cent "A" debenture bonds and £3 accrued interest; for 6 per cent secured notes, £112 new 4 per cent "A" debenture bonds, with £3 0s. 4d. accrued interest; for 6 per cent debentures £100 new 4 per cent "B" debenture bonds, £100new preference shares, and £6 cash; for 7 per cent cumulative preference shares, £150 new preference shares; for ordinary shares, £300 new ordinary shares; for deferred shares £300 new ordinary shares.

Annual Report.—The report of the Manila Railway Company, Ltd., for the year ended December 31st, 1905, states that the traffic receipts amounted to $1,694,820 and the expenses in Manila to $723,040 leaving $971,779, which, at 2s. exchange, is equal to £97,178. The profit on working the quay line amounted to £1,429, and the profit in exchange to £242, while the charges in London were £3,790, leaving as net revenue £95,059, out of which interest has been paid on first mortgage registered stock (£7,500) and on prior lien bonds, "A" and "B" (£35,100). The value of the Philippine currency has remained steady throughout the year at slightly over 2s. per dollar. The claims against the governments of the United States and of the Philippine Islands have been settled, subject to the consent of the shareholders and security holders, on the terms stated in the chairman's circular of August 3, 1906. The company's claims on the Spanish Government are being prosecuted, but the directors regret that they are still unable to report any recoveries. The construction of the extensions has made good progress. The receipts from extensions to December 31st, 1905, are £13,305. The amount paid for interest on secured notes during 1905 was £20,250, so that a debit balance of £6,944 is carried forward to 1906.

TIENTSIN TRAMWAY SYSTEM

According to a correspondent of the *North-China Daily News*, the new iron bridge of the Electric Tramway Company in the City of Tientsin is now open to traffic. The hours of opening and closing the bridge are fixed conformably with the time-table of the trains of the Imperial Railways of North China, in the same way as the International Bridge in the French Concession which was built by the Powers when Tientsin was in the hands of the Provisional Government after the Boxer troubles in 1900. The new bridge is lighted with electricity and policed by both Chinese and Austrian constables, because it is connected with the Austrian Concession on the other side of the Peiho. The structure is practically divided into four parts, *viz.*, two sidewalks are reserved for pedestrians, while one-half in the middle has been laid with rails for the passing of the electric cars and the other half for vehicles. The company is now laying rails in the Austrian, Italian and Belgian concessions at Hotung, east of the Peiho, in order to run cars straight to the Settlement Station of the Imperial Railways, and the first cars will soon be placed in commission. The company is negotiating with the Japanese municipal authorities at Tientsin for the tramway to pass through their concession. It is believed that the company will also shortly commence negotiations with the French, British and German authorities for the same purpose, so that passengers will be able to travel from the various foreign concessions to the city and *vice versa* without interruption in future. Sometime ago, the company had trouble with the Chinese officials arising out of the accidents to native pedestrians alleged to be caused by carelessness on the part of the Chinese conductors. But this defect has now been practically remedied by the placing of nets outside the moving cars and the stationing of coolies with red flags, in the day time, and red lamps during the night, at the most important points of the route by the company and the issue of an official notice by the Chinese Police Commissioner prohibiting pedestrians and ricsha coolies from being near the moving trams under pain of severe penalties. It is hoped that by the joint energy of the Belgians and the Chinese authorities accidents may be prevented hereafter. The Japanese authorities have appointed a committee to consider the proposals of the company and whether the line should be a single or double one in their concession in Tientsin.

BOOK REVIEWS

Technical Terms (Spanish and English) by Andres J. R. V. Garcia; Spon & Chamberlain, New York.

This little volume is of convenient pocket size, and contains 3,000 technical terms in both languages, conveniently indexed. Its object is to satisfy the demand for an up-to-date technical dictionary of the terms in general use by engineers. The Spanish Index will be found to be a specially valuable feature in translating from Spanish into English.

Mechanical Draft (with 27 original tables and 13 halftone plates), by J. H. Kinealy; Spon & Chamberlain, New York. (Price $2 gold, net.)

While this book is intended primarily for the practical engineer, full explanations of the various steps leading up to the finished design of the mechanical draft apparatus have been given with the hope that the book may prove of value as a textbook for young engineers and students.

Hydrographic Surveying (illustrated), by Samuel Hill Lea, M. Am. Soc. C. E.; The Engineering News Publishing Company, New York. (Price $2 gold, net.)

This work is especially intended for engineering students and the younger members of the profession; but it is also particularly useful to those of larger experience, but not familiar with the minor details of this class of work. The author takes up his subject in a clear but simple form, using illustrations very freely. Complicated mathematical forms are avoided as being actually unsuited to the ordinary methods of field work.

The Model Library; Spon & Chamberlain, New York.

Volume I of this useful work has been received and is devoted to electrical engineering, divided in four books, under the following captions:—"The Study of Electricity," "How to Install Electric Bells, Annunciators and Alarms," "Dry Batteries," and "Electrical Circuits and Diagrams."

Economics of Road Construction (second edition, enlarged; illustrated), by Halbert Powers Gillette; The Engineering News Publishing Company, New York. (Price $1 gold, net.)

This is a practical, concise and complete treatise on the economics of road construction, dealing with all branches of engineering in the subjects discussed. The fact is brought out that economic road construction is not the first consideration of some engineers, however excellent otherwise may be the structures designed by them. It is shown that to perform earthwork economically the engineer must understand the efficiency of modern tools that can be used, and so design the cross-section of a road as to make such use possible. The author has shown that deep cuts may be avoided by a consideration of the fact that the power of a team is not constant, but may be as great as 1,000 lbs. tractive pull for a short time—sufficient to mount a grade of 7 per cent with a net load of four tons, and has indicated the possibility and desirability of reducing the width of cuts by the use of sub-drain, and the necessity of keeping the mouths of such drains open. The necessity of screening all gravel, etc., are also dealt with. Altogether, the work is a most valuable one.

City Roads and Pavements (third edition, revised; illustrated), by William Pierson Judson, M. Am. Soc. C. E.; The Engineering News Publishing Company, New York. (Price $2 gold, net.)

This edition has been prepared in response to the continual call for the book as a guide in the building of rural highways as well as of city pavements. Additions are made, in the text and in the foot-notes, giving recent changes in methods. The sections entitled respectively "Concrete Base," "Block Stone," "Wood," "Vitrified Brick," "Asphalt," "Bituminous Macadam," and "Broken Stone," are made to accord with the latest records of methods and costs, using illustrations and tables for brevity.

Electrical Instruments and Testing (illustrated), by Norman H. Schneider, Spon & Chamberlain, New York.

This book is intended for practical use and also as an introduction to the larger works in "Electrical Testing." The apparatus described is modern and universally adopted. The tests are such as occur daily in the work of the test-room, powerhouse or technical school. The formulas given are explained in the text preceding them, and examples are worked out in simple arithmetic. Formulas are often looked upon as intricate mysteries by those who do not understand them. In reality they are often very simple and very necessary. The use of formulas is but a method of arithmetical shorthand. A few minutes devoted to a formula will render it clear and its use easy to those of limited arithmetical education. This is a most valuable feature of the book.

Electric Power Plants (illustrated), by Norman H. Schneider; Spon & Chamberlain, New York City.

In this revised edition the author has incorporated a complete chapter on wiring, and wherever practicable the rules of the National Board of Fire Underwriters (United States) have been followed and explanation of the rules given wherever necessary. Motors, both direct current and alternating current, are considered in a separate chapter and the modern forms of starting rheostats described at length. In the chapter on generators, the principles of alternators are considered, as also transformers and their applications. Modern testing instruments and their use, and the wattmeter, and its testing, are dealt with in a separate chapter. In the storage battery section much new information has been added and the batteries used in automobile work treated of. This addition has been made as it is the duty of most powerhouse operators to attend to the charging of automobiles either commercially or occasionally.

Modern Tunnel Practice (illustrated), by David McNeely Stauffer, M. Am. Soc. C. E.; The Engineering News Publishing Company. (Price $2.50 gold, net.)

This volume is illustrated by examples taken from actual recent work in the United States and in foreign countries. The practice of tunneling, in many of its important features, has been radically changed within a comparatively short period by the introduction of high explosives, by the use of machine drills, by special appliances for handling the debris or projecting the roof of the tunnel, and by the employment of electric power and light. As a consequence of these innovations, much that was useful to the engineer and to the contractor in the older works upon tunneling is now out of date; and with this in view the present work has been compiled. In the arrangement of this volume, especial effort has been made to present modern practice in tunneling under as many varying conditions as possible, and to clearly and concisely describe the methods actually adopted in carrying out the work under certain controlling conditions. The material used is very largely taken up, and in every case the description of any special method is prefaced by a brief statement of the physical conditions which call for some particular treatment. The composition, nature and use of modern explosives have been treated at considerable length; but under this head much has been left out that is considered as having little or no useful bearing upon modern practice in tunneling building.

Universal Dictionary of Mechanical Drawing (illustrated), by George H. Follows; The Engineering News Publishing Company, New York.

In a paper on *Mechanical Drawing in the Modern Drafting Room* read before the Engineers' Society of Western Pennsylvania, in June, 1903, the author dwelt with some emphasis upon the importance of uniformity in what he then termed the "dictionary," features of mechanical drawings. This paper was reprinted by the society as a pamphlet. As a result it seemed to be the unanimous opinion that such a dictionary, dealing with mechanical drawing as a language, would be appreciated by teachers, students, and drafting rooms alike. This book is the result. It has been written with the hope that the drafting fraternity, as well as teachers and students of mechanical drawing, will use it as the basis for the writing of the language.

PHILIPPINE RAILWAY MATERIALS

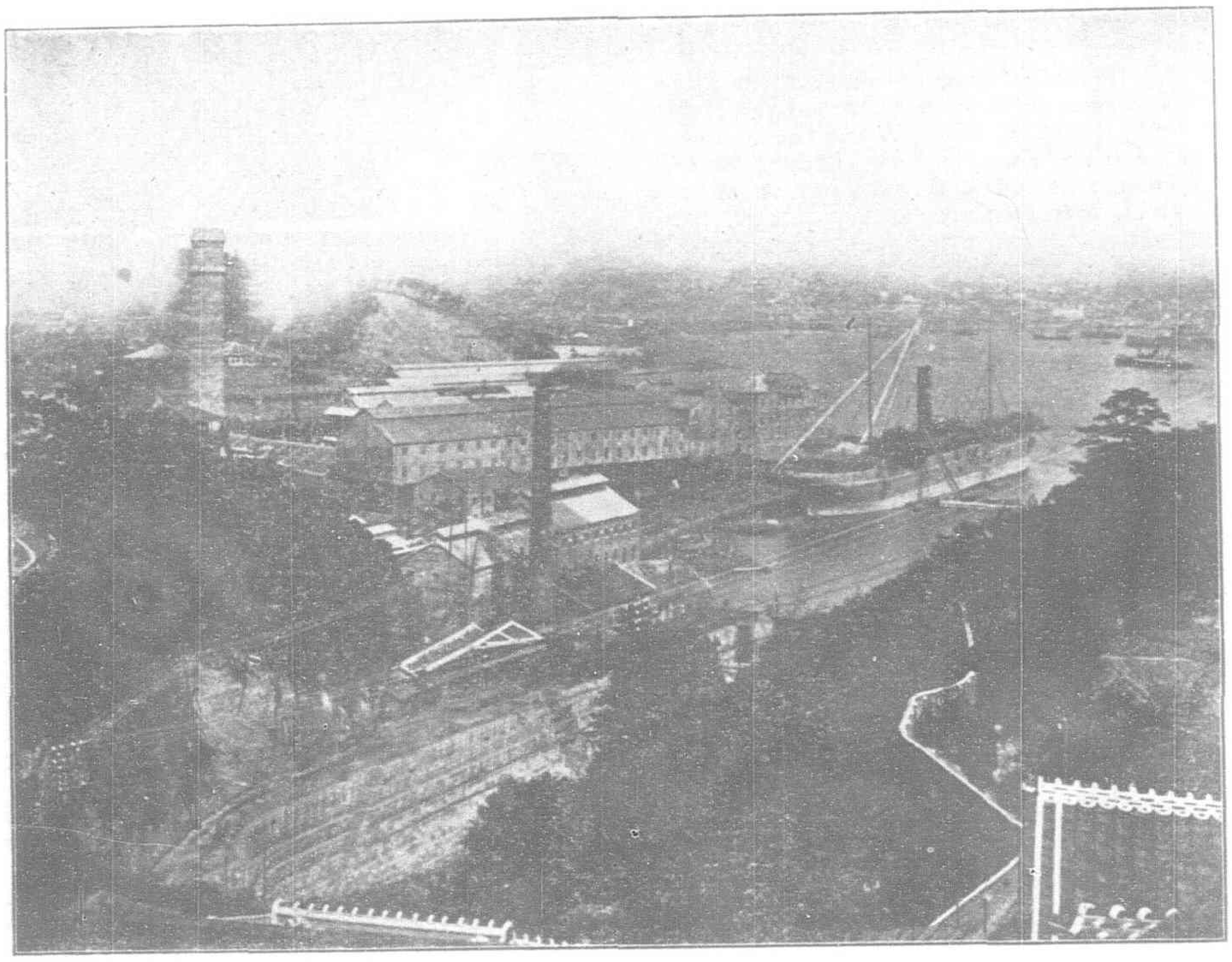
An administrative circular, issued by the chief of the Bureau of Customs of the Philippine Islands, publishes regulations for the free entry of materials to be used in the construction and equipment of the railways now building on the islands of Luzon, Panay, Negros and Cebu. Under the act of the Philippine Commission which granted the concessions to the White and Speyer syndicates, the following materials are exempted from customs duties:—(*a*) All materials used in surveying, including engineering instruments, tools, books, stationery, tents, kitchen utensils and stoves, draughting tables and draughting supplies, cots, chairs, blankets and bedding, surgical instruments and supplies, medicines, harness, saddles, and other equipments usually employed in railway surveys excluding, however, subsistence and commissary supplies and clothing and personal effects of employees. (*b*) All material for the general and local offices of construction administration, including office furniture and fixtures, stationery and supplies, testing machines and like material and supplies. (*c*) All construction material, including wagons, carts, scrapers, graders, dump carts, push cars, steam or gas traction or hoisting engines, trucks, pumps, pipe, pipe tools and fittings, pile drivers, steam shovels, steel rails and fastenings, telegraph instruments and wire, insulators, poles and other like supplies, sawmill machinery, ties, timber for bridges, water tanks and building, sashes, doors, blinds and mill work, roofing material, cement, plaster, lime, paint, varnish, and other similar building supplies, steel and iron bridges turn tables, roof trusses, and structural iron of all kinds, frogs, switches and crossings, interlocking and signal apparatus shop machinery and tools, hand tools of all kinds and descriptions, hardware, oil, coal and waste used on construction trains, ships or launches, horses, mules and draught animals, including hay, grain and forage for same, and any and all necessary material and supplies used wholly on railroads built under concessionary contracts or grants. (*d*) All material for equipment of railroads built under concessionary grant or contract or by any railroad specially granted exemption by law, such material for equipment being motive power and rolling stock for use on construction of railroad and for equipment of same to enable it to properly operate the mileage constructed under its concessionary contract or grant.

A vessel having an entire cargo consigned to the railway company at a port of entry will be allowed to unload any portion of the cargo and then proceed under special permit to any other port or place in the same collection district after the entire cargo has been entered and cleared at the port of entry. A vessel having an entire cargo consigned to the railway company at Cebu, a part of which the company may find necessary or desirable to forward to Iloilo may be permitted to clear the entire cargo at the port of Cebu and then to proceed with such portion of the cargo, on proper manifest and permits, to the port of Iloilo, for discharge in that collection district, and vice versa. Upon arrival of such cargo at Cebu from the port of Iloilo it may be treated in the same way as is specified in the preceding paragraph, with the exception of proper clearances which will have been accomplished at the port of Iloilo.

The following named persons have been empowered in due form by Mr. E. J. Beard, Chief Engineer of the Philippine Railway Company, to perform any and all acts in connection with clearing imported material and supplies at the various ports of entry, and as incident thereto to sign bills of lading, free entry, and all other documents in connection therewith, and generally to transact at the customs offices at Manila, Iloilo and Cebu, respectively, all customs business in which the said railway company is or may be concerned:—Mr. Theobald Diehl, Purchasing Agent, and Mr. C. B. Sawyer, Chief Clerk, for all ports; Mr. H. E. Geer, General Storekeeper, for the ports of Iloilo and Cebu, and Mr. F. H. Loucks, Storekeeper, for the Port of Cebu. Mr. H. S. Hogge, of Manila, has been authorized by the General Manager of the Manila Railway Company, Limited, to sign for and represent said company in all matters relating to customs and importations of material and supplies subject to free entry.

MITSU BISHI AND OTHER JAPANESE SHIPBUILDING ENTERPRISES

Japan continues to progress wonderfully in its shipbuilding and dockyard industry. The principal shipyards at Nagasaki, Osaka, Kobé and Yokohama are full up with orders. The factory arrangements are being constantly improved all along the line, and as a consequence the building of ships of over 10,000 tons in Japanese yards is now quite common. The year 1906 was one of extraordinary activity at the plant of the Mitsu Bishi Dockyard and Engine Works, Nagasaki. Besides despatching with promptitude and efficiently a large number of repair and overhaul jobs in vessels of all classes, the concern undertook the construction of no less than 12 steel steam vessels for private companies, in addition to which it has in the docks several warships to the order of the Japanese Government. During the year there were launched at these yards five steel vessels', all of which are designed for steam power. They are the *Joshin-maru*, port of registry Osaka, 1,244 gross tons, and 1,034 i. h. p.; the *Masan-maru*, port of registry Osaka, 1,244 gross tons, and 1,190 i. h. p.; the *Shirasagi-maru*, port of registry Nagasaki, 90 gross tons, and 180 i. h. p.; the *Hitachi-maru*, port of registry Tokyo, 7,500 gross tons, and 4,200 i. h. p.; the *Ogasawara-maru*, port of registry Nagasaki, 1,456 gross tons, and 1,789 i. h. p. The new work on hand for private interests includes seven steamers, Tokyo being the port of registry of all. Their respective gross tons are 13,500, 13,500, 3,700, 8,600, 8,600, 8,600 and 8,600; their respective i. h. p. is 16,500, 16,500, 8,500, 7,300, 7,300, 7,300 and 7,300. The three largest of these steamers will be fitted with Parson's turbine engines.



ENGINE WORKS OF THE MITSU BISHI DOCKYARD AND ENGINE WORKS, NAGASAKI, SHOWING 100-TON SHEERLEGS WITH WHICH THE STEAMER "HITACHI-MARU," 7,500 TONS GROSS, BUILT AT THIS PLANT, IS BEING EQUIPPED; NO. 2 DOCK IS NEAR THESE WORKS

GROWTH OF YARDS.—Work in the smaller yards is also greatly increasing. The small shipyards on both banks of the Kidzugwa have hitherto devoted their attention to the building of wooden vessels of 200 to 300 tons, but these are now able to build iron ships of 800 tons. The yards at Kayokijima, outside Nagasaki Harbor, which have hitherto been engaged in repairing work, are fast developing into a complete shipbuilding yard.

At Innoshima, Bingo, there are two dockyard companies, one of which possesses two docks measuring 300′ and 364′, respectively, while the other has a dock 410′ in length and is about to open another measuring 300.′ At Nochi and Kinoe there are two shipbuilding yards, each possessing a dock 200′ in length. Kinoe-maru has long been known as a center of wooden-ship building, and the launching of a ship of from 70 to 150 tons is an almost daily occurrence.

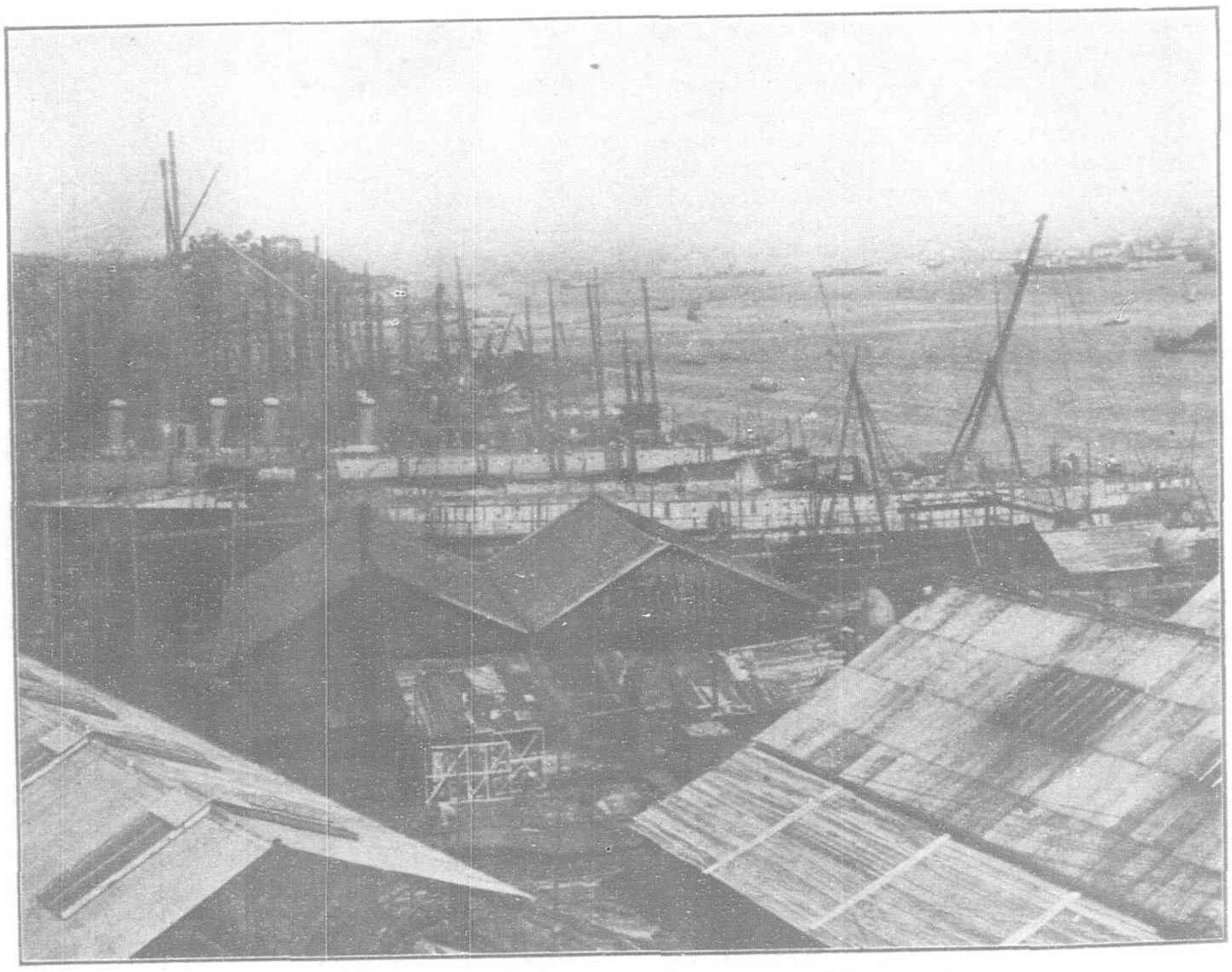
The largest dock in Japan is at Nagasaki, which measures 728′, the next being at Yokohama, with a dock of 552′, the third largest at Hakodate, being 534′ long. The floating dock owned by the Nagasaki company is 412′ in length and is capable of floating a dead weight of 7000 tons. Another and larger floating dock is now being built by the same company. The docking business, like the shipbuilding, is now in a very prosperous condition.

The technical knowledge of shipbuilding among the Japanese has also made progress, compared with eight or nine years ago, when the *Hitachi-maru*, 6,000 tons, was built. At that time the engineers and mechanics experienced difficulty in building the steamer, but now they are able to build larger vessels with greater ease and expedition. What is necessary in Japanese shipbuilding is the further subdivision of labor among the various departments of the industry. If this is done, shipbuilding can be executed with more dispatch. There is scarcely any doubt that with the development of the shipbuilding industry in Japan orders from foreign countries will increase.

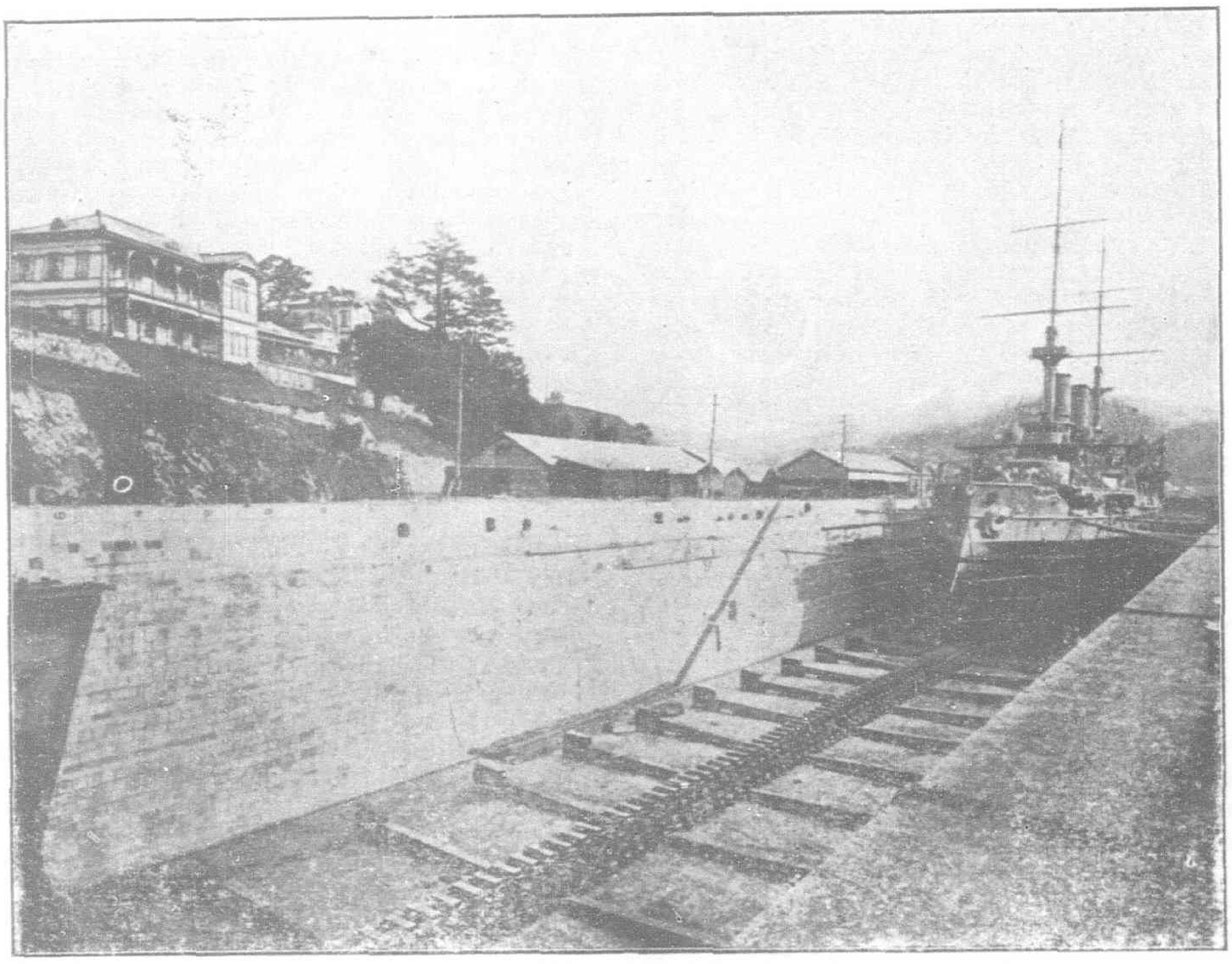
SEEKING LEADERSHIP ON PACIFIC.—The Toyo Kisen Kaisha is vigorously at work building a new trade on its new line to Chile. It has chartered the *Kusuho-maru* (formerly the *Aryol*, 9,085 tons) from the naval department and also the *Kasado-maru* (formerly the *Kazan*, 6,070 tons), and, substituting these for the one vessel hitherto on the line, it will organize a regular monthly service between Hongkong and Chile *via* Japan ports.

The Nippon Yusen Kaisha is now in strong competition with foreign steamers on the Swatow-Bangkok line, the Shanghai line, the Australian line, and the Shanghai-Hankow line. The contest is growing intense and especially strong between the Japanese company and the great British firm of Butterfield & Swire.

It is clearly evident to a casual observer that the Japanese have a belief and faith in their power to become the masters in the coasting trade of this part of the world, and are perfecting their plans with this object in view. They are laying a foundation now, which surely will give them most excellent advantages to control the shipping between the United States and the Orient. Their first advantage lies in the economy of operation, due primarily to the cheap wages and good service of their seamen and officers and the abundance of well-trained and good seamen.



PART OF THE MITSU BISHI'S SHIPBUILDING YARDS



MITSU BISHI'S NO. 3 DOCK (714' ON BLOCKS) WITH H. I. J. M. WARSHIP "IKI" ON THE STOCKS

Government Subsidies.—Subsidies are given by the Government on all ships constructed in Japan for the Japanese. The sum allotted in the budget for the current fiscal year under the heading of encouragement to shipbuilding is only $361,250 gold (which is exclusive of sums paid to existing steamship lines), and Tokyo papers say that it will prove quite insufficient. Speaking broadly, the rate paid for vessels built in Japanese dockyards and satisfying the required tests are $10 gold per ton for the hull and $5 per h. p. for the boilers. Fourteen vessels, totaling 55,488 tons, will come within the scope of the provisions, and the subsidy will amount to $1,150,000 or $1,200,000, so that there will be a deficiency of something over $750,000. The Government will probably pay it out of the reserves and embody it in a supplementary budget for the Diet's approval. The tonnage under construction amounts to 55,488 tons for the 14 vessels ordered.

In addition, the Nippon Yusen Kaisha have ordered six vessels of 8,500 tons each, and there are two ships building of 2,800 tons, which will not be eligible for bounty. Thus the total under construction is 22 vessels, aggregating 112,000 tons.

A subsidy is paid to mail steamers sailing not only to Europe, America, and Australia, but also to lines operating practically in a coasting trade in China, in connection with Japan. These steamers run on regular schedules to all of the important ports in China, going not only to Korea, Dalny, Chefoo, Newchwang, Tientsin, Tsingtau, Shanghai, and all southern ports, and to the Philippines, but they go 700 miles up the great river Yangtsze to that Chicago of China, Hankow.

At the close of 1903 Japan possessed 657,000 tons of steamers and 320,000 tons of sailing vessels. In 1905 the number of steamers was increased to 939,000 tons and that of sailing vessels to 336,000 tons, making a total of 1,275,000 tons. The vessels include 338 under 5 years, 331 from 5 to 10 years, 257 from 10 to 15 years, 181 from 15 to 20 years, and 131 up to 25 years, thus leaving only 148 over 25 years old.

Increase in the Chinese Trade.—Amoy continues to lose the Formosan tea trade with the development by Japan of Keelung Harbor, and making that the tea port for Formosa. The ultimate object is to make Keelung Harbor accessible to large trans-Pacific steamers. Japanese direct lines are being operated from Keelung to Kobe and Nagasaki, and the decrease in the Amoy tea shipments from 17,812,666 lbs. in 1902 to 12,304,495 lbs. in 1905 shows how much these lines have affected local shippers. In Amoy's busy days three British steamer lines were operated between Formosa and Amoy, but the Japanese lines have driven them entirely out of the Formosan trade. The company accomplishing this is the Osaka Shosen Kaisha, which now operates 11 ships plying up and down the coast, calling at all the ports between Hongkong and Shanghai, and from Amoy to Tamsui and Keelung in Formosa. Douglas Lapraik & Co., which firm formerly had seven steamers, has curtailed its run from Hongkong to Fuchau, and is operating only three steamers. Butterfield & Swire still maintain an irregular service, but the major portion of its once enormous coast fleet is tied up in Hongkong or Shanghai.

This remarkable growth in Japanese owned and operated steamers is due largely to the subsidizing of Japanese steamers by the Japanese Government. This subsidizing enables the Japanese lines to maintain their service with low freight rates that can not be met by the British companies.

Japanese goods are being pushed and find a ready market, while the products of other nations, similar in character but better in quality, find no market. Japanese firms are gaining a foothold in the treaty ports, and the number of the Chinese that are becoming Japanese subjects is surprising. It might be well to mention that the Japanese consuls have power to confer Japanese citizenship upon Chinese subjects. There are in the various treaty ports of China, according to the last Imperial Chinese Customs report, 729 Japanese firms and 16,910 Japanese citizens. The next in rank are British firms to the number of 434, with 8,493 British citizens. The United States shows 105 firms and 3,380 citizens, and Germany 197 firms with 1,850 citizens.

CAN CHINESE RUN THEIR RAILWAYS?

China Coast papers have been discussing this question during the last month with more or less avidity, and the following article on the subject, reproduced from the *China Mail*, indicates quite well the trend of the discussion:—

"The condition of unrepair into which the Canton-Samshui Railway has fallen during the two years it has been open to traffic, has of late been much discussed in business circles. On all sides, without exception, as far as we have been able to hear, the blame for this has been thrown on the Chinese authorities. The general opinion appears to be that, as with other things, the Chinese, once having built a railway line, expect it to last forever, and go on earning money without further outlay on their part. This is known to be so with Chinese-owned ships—the meanest run ships on the coast—and with armament, cannons once bought being allowed to rust into uselessness to save the expense of keeping men to look after them properly. Warships share the same fate, while a walk in any really Chinese town will show bridges, houses, temples and numerous costly works crumbling away for the want of the proverbial stitch in time.

"Such are the arguments used against the Chinese when it is asked, 'Can they run their own railways?' and the Canton-Fatshan and Samshui line would at first glance appear to be direct evidence in favor of a negative answer. However, before passing judgment it is well to hear both sides. We have on numerous occasions heard the story from the standpoint of the foreigner, but a chat a representative of the *China Mail* recently had with Mr. K. G. Kwong is one of the first opportunities of hearing what the Chinese have to say for themselves.

"Mr. (or Taotai) Kwong, it may be explained, was some three or four months ago appointed engineer-in-charge of the Yuenhan Railway Company's lines. He is a Chinaman of the modern school, with very advanced ideas, speaks English perfectly, and has a knowledge of railway matters acquired during eight years' study in America, where he was generally recognized as a keen observer and a man of ability.

"Taxed with the somewhat aggressive assertion:—'You Chinamen are a nice lot to attempt and run railways—You never think of repairs—Just look at the line between Shekweitong and Fatshan!' he replied:—'Oh, yes; you always say it is we Chinese! Often, perhaps, you are right; but this time you are wrong. Now the Swatow-Chaochowfoo line was built under close Chinese supervision by the Japanese; it is a fair line. It could be improved in many ways, but it is fair. The Canton-Samshui line was built by foreigners (Americans) and is a disgrace to all who were connected with it. It was never properly constructed. There came a time when a line of some kind had to be built, and things were not ready. Some kind of a roadbed was hurriedly thrown up and rails laid, and there was the line which you blame us for not keeping in good condition. The task was impossible from the start and all that can be done is what we are doing now—practically rebuilding the whole thing.'

"The interviewer was aggressive, and replied:—'You people are ever good at explanations. You *squeeze* nearly all the money that should be spent on repairs and then rely on something like this to explain it away.'

"'Well, I like that,' retaliated Mr. Kwong. 'Chinese officials and others do *squeeze*, and I am not going to deny, and I have seen some fairly good examples of it. The best samples of *squeeze*, however, that I have ever known or heard of are insignificant compared with things I could tell you about your boasted foreigners and our railway lines. Mind! I have the books. Things doubled in price in a most mysterious way. We paid high prices and got nothing worth having for our money.'

"Mr. Kwong added that he knew how a railroad should be run and how it should be built. The Yuenhan Company was spending money freely on its branch line and when in a few months' time the repairs are completed it will be, for the first time, he declared, in thorough good working order. On the Hankow line the company was also making progress and it would not be many months before the first section of 10 miles would be open to traffic. All the fighting and squabbling that had taken place about the directorship of the Hankow line was so much bearing the air. The main point was that the money was safe and the people were interested. A good line would be built and the prospects for its success were very satisfactory."

FIGHT AGAINST THE SUGAR INDUSTRY OF THE PHILIPPINES

[In an address at the recent banquet of the National Association of Manufacturers, held in New York City, Mr. William H. Taft, Secretary of War and formerly Civil Governor of the Philippine Islands, made a strong plea in favor of fair commercial treatment of these possessions by the home country. Extracts of this address are reproduced herewith, together with our own analogous observations.—EDITOR'S NOTE.]

Recurring to the special interests that are opposing the Philippine Tariff Bill, they are, first, those interests that are raising and manufacturing sugar in this country, and I am going to ask you to go into a few statistics with me upon the subject of the consumption and the production of sugar in this country and in the Philippines, because without doing that you can not understand the question—*Secretary Taft*

A trust capitalized at $20,000,000 gold is at present being formed by the Louisiana sugar planters and manufacturers, with one of the Oxnards as an incorporator, according to a recent issue of *The Louisiana Planter and Sugar Manufacturer.* This means nothing more nor less than a merger with the American Sugar Refining Company. Already the beet-sugar factories have gone into the trust, and now the cane-sugar interests of Louisiana are taking the same step. So all the sugar interests of the United States are coming under one head—the American Sugar Trust. Of course this trust will continue to fight the reduction of duties on Philippine products, where the friends of the trust are most numerous, in the Senate of the Congress at Washington. It would certainly seem about time for the Administration to rebuke this huge combination, to the extent, at least, of placing it in a position where its fight against the removal of the duties on the products of these Islands.

The demand in this country for sugar amounts to 2,700,000 tons *per annum*, and we raise in this country, including Porto Rico, and Hawaii, and Louisiana, and the beet-sugar production, 1,100,000 tons, of which 300,000, or exactly 265,000 tons, are produced by the beet-sugar manufacturers. Now, that leaves to come off the tariff wall, 1,600,000 tons of sugar, and we exported from the Philippines last (1905) year 100,000 tons to everywhere, and half of it came here. Now, of that 1,600,000 tons, about 1,000,000 tons came from Cuba and paid a duty of 20 per cent less than the Dingley Tariff. Fifty thousand tons came the same year from the Philippines, and paid a duty 25 per cent less than the Dingley rate, and 450,000 tons of Java, paying the full Dingley rate; 100,000 tons came from the West Indies and other islands, paying the full Dingley rate. Now, it is not necessary for me to explain to intelligent business men, men of affairs, that what will affect the producer of sugar in this country is the reduction of price. That is the first proposition. Secondly, it is not necessary for me to explain that the price of sugar in this country, as long as we have to import sugar and bring it over the tariff wall, is fixed by what it costs to import the sugar into this country. And it follows that as long as we have to import sugar and bring it over the tariff wall at the full Dingley rates, the introduction of sugar from the Philippine Islands can not affect the price at all. All that it will do will be to substitute it for sugar that now pays the full Dingley rate, or that pays 20 per cent off the Dingley rate, and that is all.—*Secretary Taft.*

Consumption of sugar the past (1906) year in the United States, while official figures are not yet at hand, is known to have been larger than ever before. The beet-sugar lobbyists last spring at Washington claimed that the quantity of sugar going into the United States paying the full rate of duty, would be cut down to 100,000 or 200,000 tons in 1906; and to nothing in 1907. As a matter of fact, it will be shown to have been much nearer 1,000,000 tons of full-duty sugar entering the home country in 1906 than it was 100,000 tons. The sugar people invariably calculated on phenomenal increases in consumption. The United States has for 50 years or more, increased her consumption much faster than her production and in all probability will continue to do so. The American beet-sugar production will prove larger in 1906 than ever before. The Louisiana cane crop, however, will be shorter than for some years. The decrease from Louisiana will hardly be made good by the increase in the beet production. In the meantime consumption of sugar in the United States is growing enormously, being much larger last (1906) year than was ever the case before. Instead of the United States growing in production so as to supply her own needs of sugar, the requirements from the outside are increasing constantly in spite of the addition of sugar-growing colonies such as Hawaii and Porto Rico. If the sugar of the Philippine Islands were also admitted free, the same condition would continue—the consumption would grow faster than the production, and no sugar-grower in the homeland would be hurt.

In other words, all we are asking for the Philippines is an opportunity, with the beet-sugar men and the Louisiana sugar men, to share the opportunity to get at that 1,600,000 tons that now come over the tariff wall. We would like to have an opportunity to furnish part of that, at the price that is paid in this market for sugar. Now, the objection made is that the Philippine Islands have such capacity for producing sugar that the minute you let them into this market, the 1,600,000 tons of sugar that we now import will be produced in the Philippines. In other words, the production of sugar in the Philippines must increase 16 times before it can affect the price of sugar in this market to the detriment of those who are now manufacturing sugar and selling it behind the tariff wall. Now, I ask if that remote contingency of a growth of 16 times in an industry in the Philippines is not a dream of something so remote that it ought to be disregarded altogether in the question of doing justice to the Philippine Islands.—*Secretary Taft.*

The Philippine sugar production virtually continues at a standstill. Production has gone up from about 100,000 tons of sugar to 125,000 tons in a few years, but it must be remembered that this sugar is of so low a grade as to be worth no more to the refiner than 80,000 or 90,000 tons of 96 degree sugar now turned out by all the up-to-date sugar countries. It is too early yet to predict what the present crop will amount to, though it is known that the smaller part of the crop grown on the Island of Luzon is quite poor; and there is, unfortunately, no sign of improvement in the general sugar business elsewhere throughout the Islands. No new machinery is going in except of the same kind as the old, which is constantly wearing out. Three-roller mills and open castiron kettles for boiling are universal, as has been the condition in the Islands ever since the commencement of the industry. The molasses is all cooked down nearly dry with the sugar, so the product must of necessity be of very low grade and of unsatisfactory value. Yet the sugar industry of the Islands and its prospects continue to scare the wits out of the sugar people of the United States.

You will hear a great deal said about the labor in the Philippine Islands and the cheapness of it. If you had to do with that labor I think you would find it was not so cheap as the *per diem* represents. Those people have not been taught to labor. That is one of the things we have to do. The minute that the sugar industry is increased, the wages increase. Our coming into the Philippines has more than doubled, and in some cases trebled, the price of labor there. The sugar industry in the Philippines is in a deplorable condition. Sugar is not being raised and rice is being grown instead of sugar. Now, I ask those to whom I address these remarks to use their influence in favor of doing something which is simple justice to the Philippine sugar planter and which is no injury to any interest of the United States.—*Secretary Taft.*

The mission of Commissioner Judd, representing the Hawaii Sugar Planters' Association, to recruit laborers in the Philippine Islands for the canefields of Hawaii, is acknowledged by the Honolulu papers to have proved a signal failure. Mr. Judd spent several months in the Philippines, and finally left the Islands with about 14 Filipino laborers. The native laborer has never up to this time shown much enterprise in the way of hunting for work or business opportunities. The Filipinos as a whole have never done much from a business or industrial standpoint. There extreme timidity is aptly illustrated by the fact that populous communities live from year to year on land owned by others and pay about two-thirds of all the crops grown to landlords, while within 10 miles in any direction may be found thousands of acres of public land of much better quality than that which they are cultivating which the Government is unable to induce them to homestead and occupy free. Our sugar and tobacco friends in the United States need not have such violent frights about the Filipinos flooding the home markets with sugar and tobacco for a few generations to come.

BRITISH AND CHINESE CORPORATION, LIMITED

At the recent annual meeting of the British and Chinese Corporation, Ltd., in London, Mr. W. Keswick, M. P., presided.

According to *The London and China Express*, the chairman, in moving the adoption of the report of the directors, said that during the past fiscal year the corporation issued no railway loans for the Chinese Government, and, making allowance for this fact, the financial result might be regarded as not wholly unsatisfactory. The construction of the Shanghai-Nanking Railway was making good progress. About 80 miles were open for traffic, 20 miles more would be opened early in the present (1907) year, and the rest of the work was so advanced that the consulting engineers (Sir John Wolfe Barry and Mr. A. J. Barry) anticipated that the entire railway would be finished by June, 1908. If a perfectly free hand had been accorded to the corporation it could have accelerated construction considerably, with the double advantage to the Chinese of a saving in cost and interest and the securing of traffic at an early date. In the present state of things in China, however, this had not been possible, and the consequence was that there had been much loss of time. Taking this circumstance into account, satisfactory progress was being made, and the railway was being constructed in every way as a first-class trunk line of standard gauge, equipped with the best type of modern rolling-stock, and the cost was moderate. Before long it would be necessary to provide funds to complete the line, and the Chinese had accepted their offer for a further installment of the loan which would be issued in due course. The board were anxious to proceed with the Soochow-Hangchow-Ningpo Railway, which would also serve a very populous and prosperous section of the Yangtsze provinces. It would be the subject of a separate and distinct loan, and would be a separate undertaking, but its natural relations to the Shanghai-Nanking Railway, with which it would be linked up at Soochow, suggested that the two lines would be advantageously worked under one administration. A contract had been concluded with the Chinese for a loan to build a railway from Canton to the border of Kowloon, where it was designed to connect with the railway which the Government of Hongkong was constructing to that point from Hongkong. This would make the direct railway connection between Hongkong *via* Kowloon and Canton, which had so long and so ardently been desired by the colony. The loan was for £1,500,000, and was to be issued within eight months at the call of the Chinese Government. As regarded the Nanpiao coal concession, there was nothing to be added with advantage to what was stated in the report. With regard to the investments, he said that they consisted of 22,500 shares of £1 each, 8s. paid, and 225 deferred shares of £1 each, fully paid, in the Chinese Central Railways, Ltd., and 25,000 shares in the British and Korean Corporation. The Korean corporation had so far proved disappointing, the ore, which at first was of a very high grade and yielded gold of the value of about £150,000, having become impoverished below a certain level. The shares had now been written down to the value of £5,000. The Korean corporation had another *proposition* in view which it was hoped might prove of a more permanent character.

FAR EASTERN ENGINEERING, CONSTRUCTION, COMMERCIAL AND FINANCIAL NEWS

PERSONAL

Mr. William B. Poland, Vice-president and General Manager of the Philippine Railway Company, for which corporation Messrs. J. G. White & Co., Inc., are constructing railways on the islands of Panay Cebu and Negros, Philippine Islands, has arrived in Manila and assumed the duties of Chief Engineer in the interest of the company he represents. Mr. Poland has an enviable record in railroad circles of the United States. He is a graduate in civil engineering of the Massachusetts Institute of Technology, class of 1890, and in 1890-91 he attained a post graduate scholarship in advanced engineering. In 1891-92 he was employed in the service of the United States River and Harbor Works as Superintendent of Construction in charge of location and construction of the Point Judith Harbor of Refuge, and Inspector in charge of a wrecking district on the New England Coast. In 1892-93 he held the position of Engineer in charge of preliminary and location surveys and maintenance work on the Pittsburgh & Erie Railway in Indiana and Illinois, and in 1893-98 he was Assistant Engineer of maintenance of way on the Chicago Division of the Cleveland, Cincinnati, Chicago & St. Louis Railway (Big Four), in charge of surveys of yards and terminals and reconstruction work, and in charge of maintenance of way of 460 miles of road. During 1898 he served in the Spanish-American War as Major of Engineers, Indiana National Guard, during which time he also acted as Battalion Adjutant of the 158th Indiana Volunteers. He also held in this year the position of Supervisor of Bridges on the Cairo Division of the Big Four Railway, and Engineer of Construction in charge of the reconstruction of the Baltimore & Ohio Southwestern Railway between Cincinnati and St. Louis, involving an expenditure of about $3,500,000 gold. In 1899 he was Division Engineer of the same line, in charge of both construction and maintenance. In 1902 he was Division Engineer of the Pittsburgh Division of the Baltimore & Ohio Railway, in charge of heavy construction and maintenance, and in 1902-04 he was Superintendent of the Indiana Division of the Baltimore & Ohio Southwestern line. In 1905 he was Chief Engineer and General Manager of the Alaska Central Railway. Mr. Poland is a son of General Poland, U. S Army, retired. He is a member of the American Society of Civil Engineers and of the American Railway Engineering and Maintenance of Way Association, in which he has taken a prominent part and contributed valuable and useful information on railway topics. He comes to the Philippines highly recommended from numerous sources, and is considered one of the foremost railroad engineers in America although yet a comparatively young man.

ELECTRIC RAILWAYS, LIGHTING, POWER, ETC.

Projected Lighting Plant, Nankin.—There is a movement on foot at Nankin, China, for the establishment there of an electric lighting plant. At present the *maloo*, the broad, principal avenue of the city, is lighted by diminutive lamps, with feeble lights some 200 yards apart. The imperial mint possesses the only electric-light installation in the city.

Japanese Demand for Wires and Cables.—With the immense development of electrical enterprises in Japan the demand for copper wires and cables is increasing daily, and the Furukawa Copper-Mining Company has decided to establish a new factory for the manufacture of copper wires at Nikko, the present factory being found to be inadequate to meet the demand. According to the latest report the total output of copper wires from this company's works amounts to about 400,000 *kin* (*kin* 1⅓ lbs.) per month, which is chiefly supplied to the various cable manufacturing companies of Tokyo and Yokohama. The majority of the covered wires and cables used by the Department of Communication is imported from abroad and the native manufacturers are said to be contemplating a cable factory on a very extensive scale.

RAILWAYS AND RAILWAY SUPPLIES

Kiangshuh Railway.—The first section of the Kiangkan end of the Kiangkan-Hushuh Railway has been opened and the works on the section from Hushuh have been commenced. The bridge which is to span the river will be built first.

New Manchurian Railway.—The Peking Government is negotiating to raise a loan from a French syndicate to build a railway along the Sungari River between Samsin and Kweihuacheng by employing Japanese engineers, the material also to be supplied from Japan.

Japanese Railway Nationalization.—Thus far the Japanese Government has taken over three private lines in the main island, *viz.*, the Nippon (-Y 130,-[illegible]40), the Sanyo (-Y-74,012,980), and the Nishinari (-Y-1,956,505), the total amount involved being -Y-206,-582,[illegible]25. None of this money has yet been paid.

Ishikari Tanko Railway.—This enterprise covers a length of about 120 miles through the coal and lumber districts of Sorachi, Kashinai, and Shinyubari, in Japan, and the Government has decided to grant permission for the construction of the railroad for the special use of this company and not under the jurisdiction of the track regulations.

Eastern Siberian Railway Extension.—A Paris telegram announces that the Russian Government has decided to construct a railway to a point south of Vladivostok *via* Stretchensk and Habarovsk, in order to promote the development of Vladivostok. Russia intends to float a loan in France and Germany for this purpose. Work will commence in the spring.

Projected Amur Railway.—A St. Petersburg telegram says that the construction of the projected Amur Railway, which is to be commenced in the next fiscal year, is inevitable in view of an article of the Portsmouth Treaty, which entitles Japan to prevent Russia from using the Manchurian Railway for any military purposes —that is the transport of troops or military stores.

Wuhu-Kuangtechow (China) Railway Started.—The Governor of Anhui has telegraphed to Peking reporting commencement of the construction of the Wuhu-Kuangtechow Railway by the Anhui Railway Company. The work began with the building of a bridge over the Wuhu River under the supervision of a Danish engineer with the assistance of some foreign educated Chinese railway students. This is one of the railways in South and Central China to be built with Chinese money only.

Tokyo Elevated Railway.—According to the plans of the Tokyo Elevated Railway, some sections of which are under construction, the authorities aim at completing the line between Shizuoka, near Shimbashi, and Yeirakucho, not later than March, 1909. Subsequently the central station will be established, after the completion of which work three elevated lines will be laid so as to join the Kobu, Nippon (Uyeno), and Sobu railways. For this continuous enterprise the Government will ask the Diet for $5,000,000 gold, the establishment of the central station alone requiring an outlay of about $500,000.

Railway Car for Empress-Dowager.—The new parlor car which the Empress-Dowager of China ordered in France some months ago for the use of herself and the high mandarins of her suite in their journeys through the country, has been shipped to Peking. The car is divided into six compartments. First of all come two drawingroom *coupés* fitted with divans covered with pale blue silk. These are designed for the attendants of the Empress, and next to them comes the sitting and diningroom of Tsi An herself, which takes up the whole width of the car and receives its light through six great panels of glass reaching from floor to roof. At both ends of the saloon are wide divans, which can be turned into beds when occasion requires.

Railway Bridge Across Yalu.—The Tokyo Government is reported as having decided to build a railway bridge across the Yalu River at the terminus of the Seoul-Wiju Railway, at a cost of about -Y-2,000,000. The bridge, which is to be built at a height of over 40′ above the water, will be 3,239′ long, and will permit of the biggest junks passing underneath by lowering only the mainmast. The structure is to be divided into two parts, one side for railway traffic and the other for vehicles and pedestrians. The work is to commence in April and is to be completed towards the end of 1909. By the time of its completion the Mukden-Antung Railway will be opened to traffic, and a through train service between Fusan and Mukden inaugurated.

Malaysian Railway.—Since the opening of the 33-mile extension of the Federated Malay States Railway, from Tampin, Malacca, to Gemas, Negri Sembilan, the railway extension further south, through Johore, to Johore Bharu, a distance of 120 ½ miles, is proceeding very rapidly, and there are indications of the line to Singapore being completed sooner than was expected a few months ago, when it was estimated that two years would be consumed in completion of the line. The opening of the 33 miles of railway mentioned makes a total distance of the main line now open of 352 miles, thus giving a through service from Penang, Straits Settlements, to the Negri Sembilan-Johore boundary, and upon completion of the section now under construction through Johore a through service will be in operation between Penang and Singapore.

Canton-Kowloon Railway.—According to *The London & China Express*, much satisfaction is felt in London at the successful termination of the negotiations concerning the Canton-Kowloon, Railway. The conclusion of this long-debated matter is considered a promising sign for the arrangement of other railway negotiations pending in China. The Canton-Kowloon Railway is intended to run from the Kowloon Territory of the Hongkong Government, which is situated on the mainland of China, to the City of Canton. The distance traversed by the line will be about 102 miles, and the route is through a fertile and thickly-peopled country. It will form the most direct communication between Hongkong and Canton. The building of that part of the line in Chinese territory has until now been delayed, owing to the obstructive policy of Chinese officials, but at last they seem to have given way under the pressure of an enlightened Viceroy. The ratification of the agreement involves the issue of a sterling loan for about £1,500,000 in London.

Tourane-Hué Railway, French Indo-China.—The railway line from Tourane to Hué, French Indo-China, has been opened to traffic. The construction of this line was commenced in the summer of 1901, and its length is 107 kilometers. Leaving Tourane, it follows the coast, and crosses successively the secondary chains which detach themselves from the great Annamite Mountain Range and which extend to the sea, notably the important group of the *col des Nuages*. The railroad includes numerous iron bridges and tunnels, and, notably, between Tourane and Hué, a bridge of 350 metres across the river of Cudé, twelve bridges of 40 to 120 metres, and eleven tunnels representing a total length of 3,290 metres, including two of 840 and 562 metres, in the crossing of the *col des Nuages*, one of 422 and eight of 355 to 110 metres. In spite of this large number of tunnels, the line, following an elevated route along the coast for the largest part of the journey, offers to travellers similar scenery to that of the ancient Mandarin route, which was almost sublimely picturesque. But, further, the Annamite River population will derive considerable benefit. This population, fairly scattered, was really exhausted by the forced labor demanded from it for the transport of goods and passengers. On the other hand, it was difficult to get at Hué by way of the river, owing to a dangerous bar which renders its mouth difficult of access.

PUBLIC AND PORT WORKS, DOCKS, WHARVES, ETC.

Bangkok Docks.—It is announced that German firms are making an effort to secure control of the Bangkok Dock Company.

Improvements at Canton.—As the work of improving The Bund of Canton progresses the waterfront is assuming a very different appearance. There are already a number of prominent buildings that give the city something of the appearance of a western rather than an eastern metropolis. Several stretches of The Bund have been completed. While it would not be difficult to find fault with the construction, and many repairs will soon have to be made, the roadway will be immeasurably better than anything Canton has enjoyed hitherto and add much to the prosperity of the city. One of the finest buildings on The Bund is that of the Electric Supply Company. New buildings have been erected upon Dutch Folly and some of the old ones have been repaired.

Waterworks Plant for Nankin.—Agitation for a modern water supply at Nankin, China, has been revived. At the present time the best drinking water obtainable is the yellow, dirty water of the Yangtsze River, which is delivered in water carts at the residences. This is boiled or filtered, or both, and used for cooking and drinking purposes. Some few individuals have had wells sunk or bored to some depth below the surface water. An effort was made a few years ago to bore artesian wells in different parts of the city, and American machinery was brought out and looked after by an American superintendent, but, because of no previous geological examination, inadequate management, or some other reason, the attempt was a complete failure.

New Bridges for Shanghai Settlement.—Messrs. Howarth Erskine, Ltd., of Singapore, have secured a contract from the Shanghai Municipal Council to erect two new steel bridges at Shanghai at a cost of $220,000 Mexican currency. The municipality has decided to do away with the old and insecure wooden structures known as the Garden and Chekiang bridges and replace them with new steel structures. The new Garden Bridge will be a massive structure of ornamental design, in keeping with the artistic surroundings of The Bund, and will, when completed, consist of two spans of over 170′ each, with a main roadway of 40′ width along each side and a footway of 10′ width. Provision is made to run a double line of tram cars in the center of the main roadway, while the entire road surface will be paved with hardwood blocks. There will be over 860 tons of steelwork in this bridge before it is completed. The Chekiang Bridge is of the lenticular girder type, and is to have a span of 196′. It is also of massive construction to take the load of running tram cars as well as the pedestrian and heavy street traffic. The weight of the steelwork in this bridge will be over 360 tons. A feature in the erection of these bridges will be the method adopted in carrying on uninterruptedly the existing road and water-borne traffic, and this will be no small task when one considers the amounts there really are at these two points.

SHIPBUILDING AND GENERAL MARINE MATTERS

"Australian" a Total Loss.—The liner *Australian*, aground at Vashon Head, North Australia, has been abandoned as a total loss

Japanese Destroyer "Minatsuki."—The trial trip of the new Japanese destroyer *Minatsuki* was satisfactory, the vessel developing a speed of 29.95 knots per hour.

Proposals for Hull, Manila, P. I.—Sealed proposals in triplicate for the construction of one (1) hull for a stern paddle-wheel steamer will be received at the Office of Water Transportation, Quartermaster's Department, Manila, until 10 a. m., February 4th, 1907, and then opened. Blank forms and general description of the vessel will be furnished upon application to the officer in charge of water transportation, Manila. Envelopes containing proposals should be indorsed "Proposals for the Construction and Delivery of One Hull for Stern Paddle-Wheel Steamer, to be opened at 10 a. m., February 4th, 1907.," and addressed W. S. Scott, Captain, Quartermaster, U. S. A.

"Wooling-Maru" in Service.—The new steel twin-screw steamer *Wooling-Maru*, built by the Kawasaki Dockyard Company, Ltd., of Kobé, to the order of the Konan Kisen Kaisha for service on the Hankow-Honan run, has been placed in commission. Her dimensions are as follows:—Length between perpendiculars, 228′ 8″; moulded breadth, 39′ 5″; moulded depth to main deck, 9′ 5″; draught (light), 4′; draught (loaded), 7′ bunker capacity, 120 tons cargo capacity, and about 600 tons on loaded draught. The gross tonnage is 1,458, registered tonnage 904, and the vessel has a speed of 13 knots. Particular attention has been paid to the needs of passengers, particularly Europeans.

Java-China-Japan Steamer "Tjikini."—The steamer *Tjikini*, constructed for the Java, China and Japan Line, has been launched from the dockyard of the De Schelde Royal Company at Flushing. The vessel has a length of 373′, a width of 45′ 5″, and a depth of 30′, with a loading capacity of 7,000 tons. It is principally destined for the cargo service, but has also accommodation for some first and second-class passengers, and for a larger number of other classes. Special installations have been made for quick loading and discharging. The engines are of the vertical triple compound system, with cylinders of 21¼, 40, and 67″ diameter and 48″ revolutions, developing 1,700 h. p. with 70 r. p. m.

LAUNCH OF THE STEAMER "PERLE"—The small French steamer *Perle*, being built to the order of M. Roque by the Hongkong and Whampoa Dock Company, through the agency of Messrs. Wilks & Jack, has been launched at Kowloon. When put in commission she will ply in the subsidized French mail service between Haiphong, Quan-Yen and Monkay, on the Saigon River, the service extending from the French city to the Chinese Frontier. She is built specially for the peculiar requirements of the service, and has but a draft of 2′ so as to be able to go into the creeks and shallow parts of the river. Her principal dimensions are length, over all, 145′; breadth, 24′, and depth, 5′. She will have cabin accommodation for thirty 1st and 2d class passengers, and is fitted with compound surface-condensing engines capable of driving her at a speed of 10 knots, and supplying electric light. The system of propulsion of stern-wheel. Four other similar steamers are included in the order for the *Perle*

LAUNCHES FOR SALE, MANILA, P. I.—The Bureau of Navigation, Philippine Government, offers for sale the following property:—(*a*) The steam launch *Saisi*, a sea going launch 86′ in length over all; beam 14′ 5″; depth (moulded) 7′ 6′; draft (loaded) 7′; draft (light) 6′; built at Hongkong in 1900. She is fitted with compound surface-condensing engine, with feed pumps and all necessary fittings attached, and is in first-class condition. Her boiler is of Scotch type, diameter 6′ 6″ × 8′ 8″, in first-class condition, with all necessary fittings. The hull is sound and strongly constructed, and shows no sign whatever of deterioration. This launch throughout is in excellent condition, and is ready to be put into commission at once. (*b*) The steam launch *Jolo*, a sea-going launch 65′ in length over all; beam 11′ 4″; depth (moulded) 5′ 8″; draft 5′; built in 1890. She is fitted with compound surface-condensing engine, in good order, and a boiler of the Scotch type in fair condition. All fittings in engineroom are in good condition. This launch throughout is in fair condition and ready to be put into commission at once. (*c*) The steam launch *Suerte*, a river and harbor launch 61′ 7″ in length over all; beam 11′; draft 5′; tonnage 21.71 gross. She is fitted with compound non-condensing engine and Scotch boiler. Engine and boiler are in fair condition. This launch is ready to be put into commission at once. (*d*) Sealed bids will be received up to and including February 15th, 1907, and will be publicly opened at 4 p. m. on that day. The vessels may be inspected at Engineer Island, Manila, P. I. Further information will be given if application therefor is made to Frank P. Helm, Director of Navigation.

MINING, MINERALS AND THE METAL TRADES

STEELWORKS EQUIPMENT, JAPAN.—It having been found necessary to extend the Japanese Government Steelworks, a sum of $1,120,000 gold has been appropriated for expenditure during the current fiscal year. A further sum of $5,000,000 is needed, and when this sum is expended it is expected that the output of iron will be increased to 180,000 tons a year.

NEW ZEALAND'S MINERAL WEALTH.—Gold to the amount of $325,000,000 has been taken from the earth in New Zealand during the past 50 years, and yet the surface of the gold-bearing deposits have comparatively been little worked. Great possibilities await further prospecting and mining combined with scientific methods. The coal mines of New Zealand produce excellent coal, and in close proximity are immense deposits of iron ore awaiting development.

FOREIGN INVESTORS AND JAPANESE MINES.—Although according to a consular report, there have been a great number of mines in Japan offered for the exploitation of foreign concerns, no deal has been made as yet. The great difficulty experienced up to the present in coming to terms between the parties was the fundamental change in the system of mining. A certain English syndicate, it is reported, has, however, decided to work two or three mines as soon as the engineers arrive in Japan this month.

RISE IN THE PRICE OF TIN.—According to *The London & China Express*, it is a matter of common knowledge that the rise in the price of tin has been largely due to the falling off in the Straits supplies. Some of the bears of the metal have endeavored to make out that the decrease was not at all large; but official reports from the Federated Malay States show that in the first nine months of 1906 the export of tin, including metal contents of ore shipped, amounted to 608,381 piculs, as compared with 636,191 piculs in the corresponding period of 1905, and very much larger quantities previously.

GOLDFIELDS OF JAPAN.—Mr. Frechville, a well-known mining engineer, who was sent out to Japan by a group of British capitalists to report upon the prospects of gold-mining in that Empire, reports that for the Japanese themselves Japanese goldfields present plenty of opportunity for profit, but that British companies would bankrupt themselves trying to pay expenses in mines which are yielding Japanese rich returns. There are largely ore bodies of a low grade character, and there is any quantity of cheap labor. Nevertheless, it does not appear that modern methods of working, which are scientific and expensive, are applicable.

NORTH-EASTERN COAL MINING COMPANY, JAPAN.—This company, with a capital of -Y-2,000,000, will be established in the near future at Yumoto, Iwashiro Province. The mine, which covers an area of 2,500,000 *tsubo*, is said to contain no objectionable strata, and is full of rich veins of coal. The veins seem to grow thicker as one descends. One vein, which is 6′ in width, is divided into two by rocks in the vicinity of Roto. At a depth of about 350′ the thickness of the coal strata is more than 12′ and the quality excellent. Though the quality of the mineral is inferior to that of Kyushu and Hokkaido coal, the low expense of mining it amply compensates, it is said, for this disadvantage.

IRON FURNACE FOR HOKKAIDO.—The directors of the Hokkaido Tanko Railway Company are planning to erect an iron furnace after the purchase of the railroad by the Japanese Government. The coals of the company's mines are said to be well suited for the manufacture of iron, and as the locality extending from Poronai to Muroran abounds in iron sand, the quality of which has been ascertained to contain 80 to 90 per cent of pure iron, according to reliable authority, the scheme to set up an iron factory has been inaugurated. It has been known for some time that there are considerable deposits of iron sand along the coast of Volcano Bay in Hokkaido. It has now been ascertained that in all the rivers flowing into the bay there are also immense deposits of iron sank along the banks. The iron is free from sulphur and phosphorous impurities.

AUSTRALIAN GOLD YIELD.—The production of gold in the States of Australia and in New Zealand shows a slight decrease for the first six months of 1906:—

	First Half-Year 1905 Fine Oz.	First Half-Year 1906 Fine Oz.
Western Australia	965,372	904,861
Victoria	338,747	381,681
New South Wales	111,869	133,150
Queensland	290,478	251,986
New Zealand	238,085	252,001
Total	1,944,541	1,923,679

To which must be added the output of Tasmania, about 35,000 ounces.

FINANCIAL AND MISCELLANEOUS

JAPANESE COAL REFINERY COMPANY.—The Japanese Coal Refinery Company is about to increase its capital to -Y-2,000,000 with the extension of business in view.

NEW ANGLO-JAPANESE BANK.—A newly-established Anglo-Japanese Bank has been granted official sanction by the Tokyo Government to open a branch office at Yokohama.

AGRICULTURAL MACHINERY FOR MANCHURIA.—Mr. Thomas Sammons, American Consul-General at Newchwang, writes that the beginning of the year 1907 will mark the introduction of steam plows and threshesr into Manchuria. Many native landowners are now interested in this subject,and if the pioneer farm implements prove successful an extensive trade will be developed.

IMPERIAL CHINESE RAILWAYS STERLING LOAN.—Coupons of the Imperial Chinese Railways (Shanghai-Nanking line) 5 per cent Sterling Loan, due December 1st, 1906, are now being paid at the offices of the Hongkong and Shanghai Banking Corporation, 31 Lombard-st, London, E. C. When the Shanghai-Nanking Railway bonds were issued a few years ago at 97½, a profit-sharing note was given with every £100 bond. There is now a market for these certificates. They are quoted at £8, and Shanghai-Nanking Railway bonds (in certificates) are 103½, so that there is an excellent profit. There is a possibility of the £1,000,000, balance of the Shanghai-Nanking Railway loan being issued within the next half-year by the British and Chinese Corporation, though in this instance no profit-sharing certificates will be given with it.

SAWMILL AND RAILWAY MACHINERY, FORMOSA.—The Formosan Government has granted an extensive concession to a Japanese company to cut the timber from an area of 25 square miles, containing more than 2,000,000,000,000′. About $2,000,000 gold capital will be invested, nearly three-fourths of which will be required for the construction of a railway, which will take three years. Then the company will locate a sawmill at Kagi. The first year's cutting will be about 16,000,000′, which will be gradually increased to 25,000,000′ annually. Manufacturers of logging equipment and sawmilling machinery wishing to supply the material for this undertaking should address the Fujitagumi, Osaka, Japan, and also the chief of the Industrial Department of the Formosan Government at Taihoku, Formosa, giving in each case a full description of the equipment they have to offer.

JAPAN'S RAILWAY ACCOUNTS.—The Railway Operating Bureau of the Japanese Government has just issued a statement of accounts covering the period from May 1st, 1905, to April 30th, 1906, inclusive, and following are the earnings of Government and private railways in yen:—

	1905-6.	1904-5.	*Increase.*
State Railways	24,056,140	21,406,137	2,650,003
Private Railways	44,977,025	37,538,711	7,438,314
Totals	69,033,165	58,944,848	10,088,317

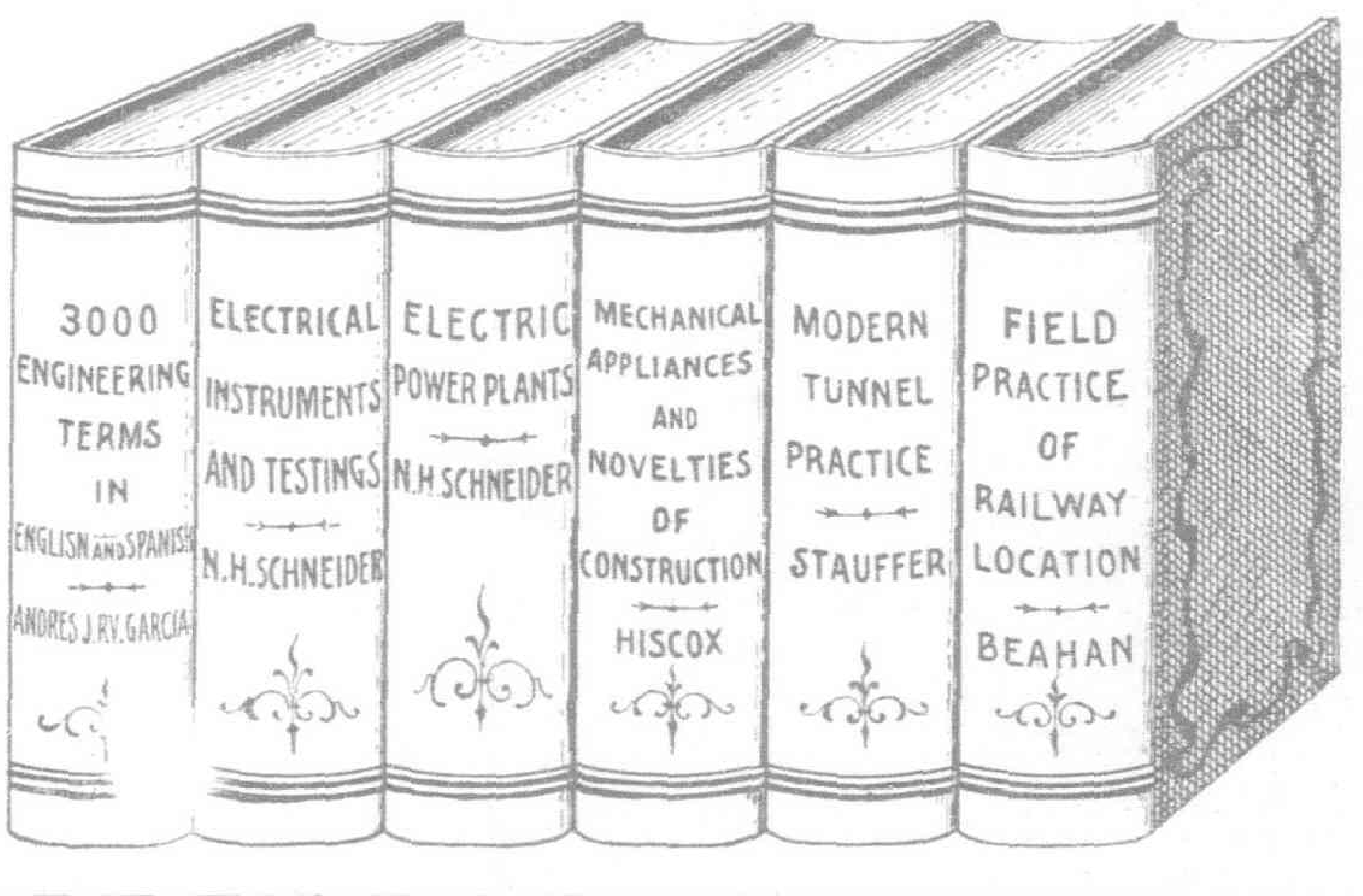
From this table it is seen that the earnings for the Government lines showed an increase of 12½ per cent in the 38th fiscal year as compared with the 37th, and that the increase in the case of private railways was 20 per cent, the combined increase being 17 per cent. The operating expenses were as follows, expressed in yen:—

	1905-6.	1904-5.	*Increase.*
State Railways	11,129,154	9,463,971	1,665,183
Private Railways	21,026,020	17,175,241	3,850,779
Totals	32,155,174	26,639,212	5,515,262

There was consequently an increase of 17½ per cent in the case of the Government lines and of 22½ per cent in that of the private lines, the increase over both being approximately 20 per cent. The net profits are shown in the following tables, amounts expressed in yen:—

	1905-6.	1904-5.	*Increase.*
State Railways	12,926,986	11,942,116	984,820
Private Railways	23,951,005	20,363,470	3,587,535
Totals	36,877,991	32,305,636	4,572,355

These results, stated with regard to the capital invested, show that the rate of profit in the case of the Government railways increased by 0.1 per cent, thus becoming 8.1 per cent for the year, while for the private lines the increase was 1.1 per cent, and the figures for the year became 9.5 per cent. Taking the grand aggregate, the increased rate of interest on invested capital was 0.7 per cent and the rate reached the fine figure of 9 per cent This is considered a remarkable showing.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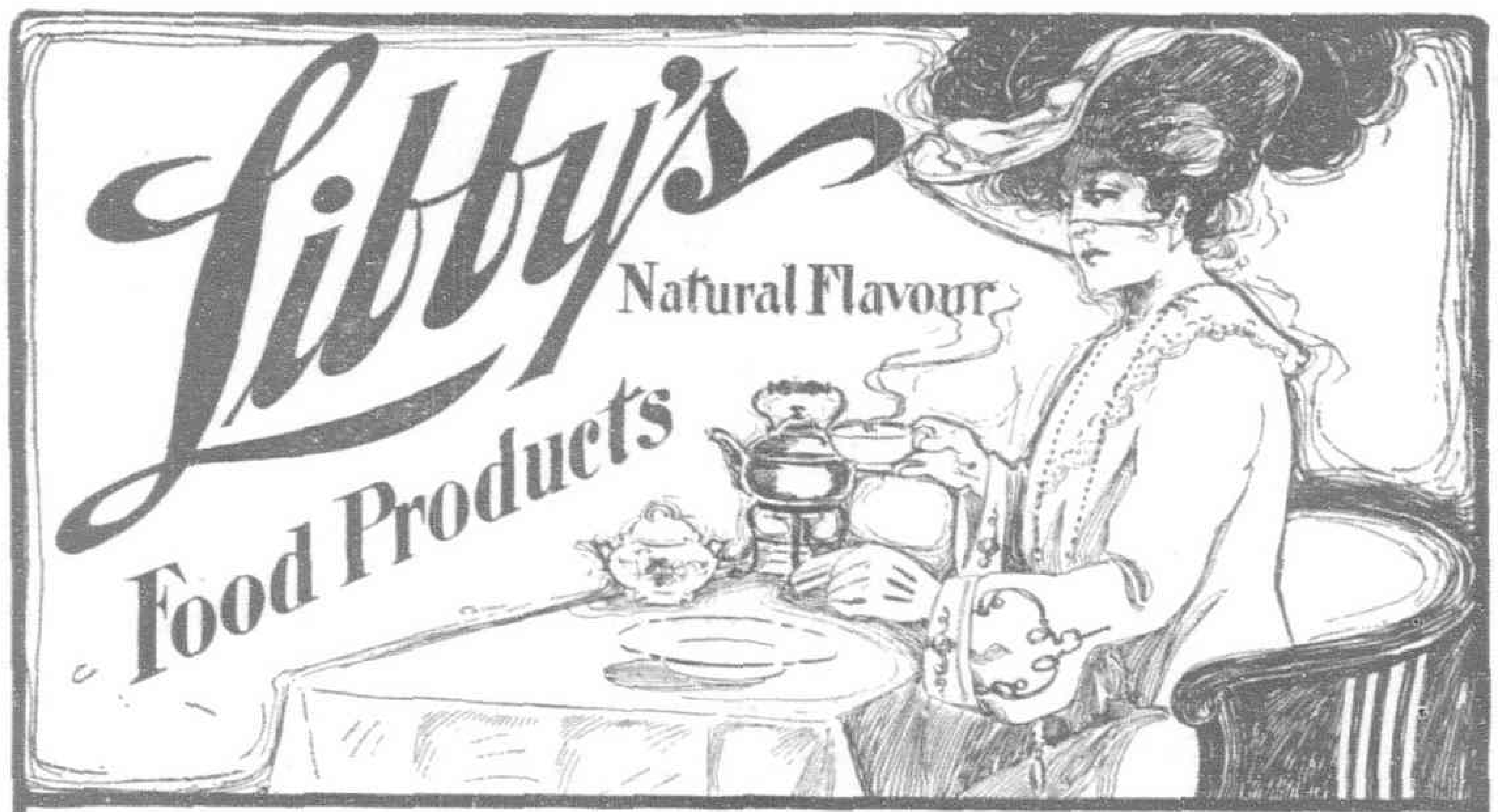

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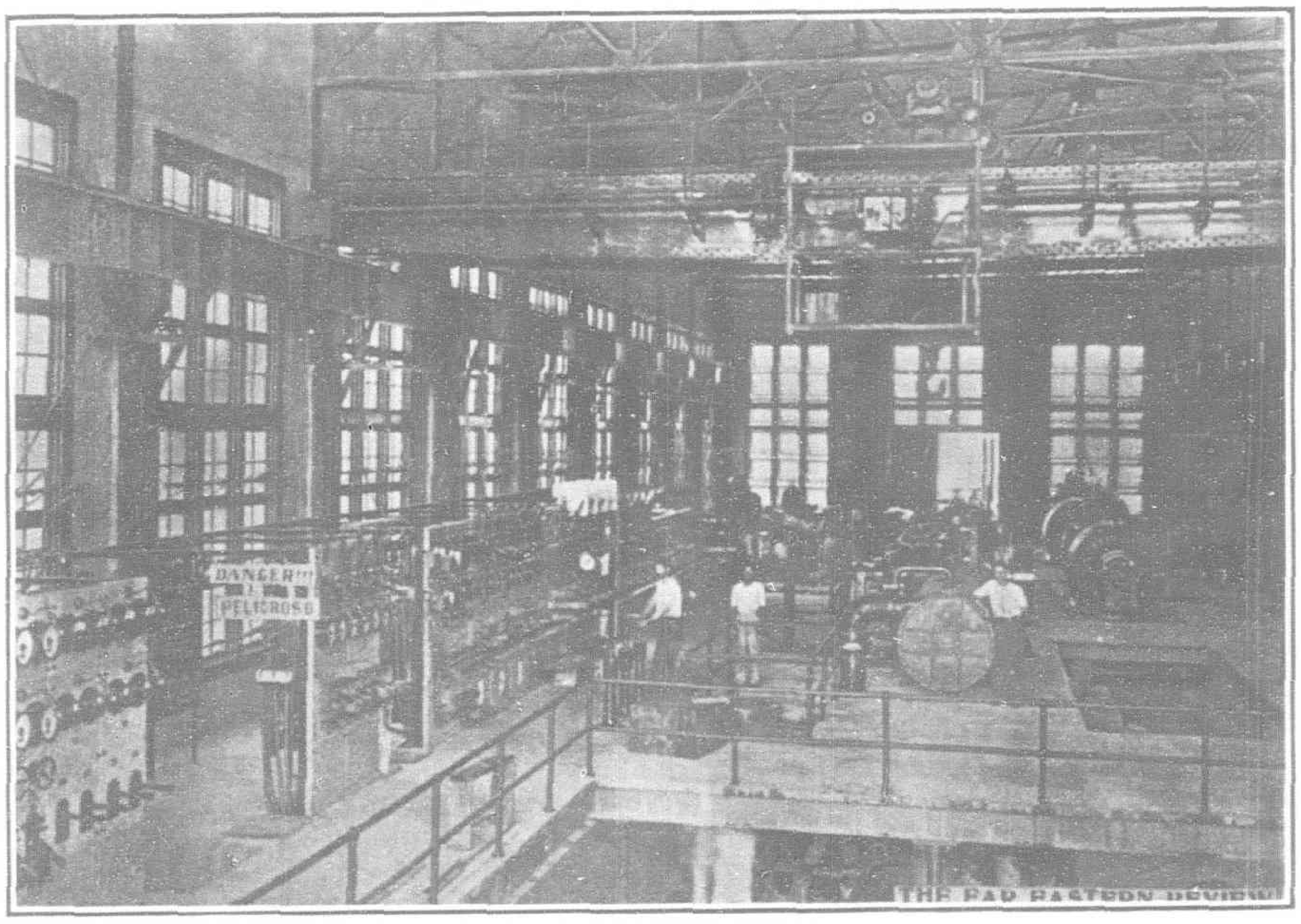

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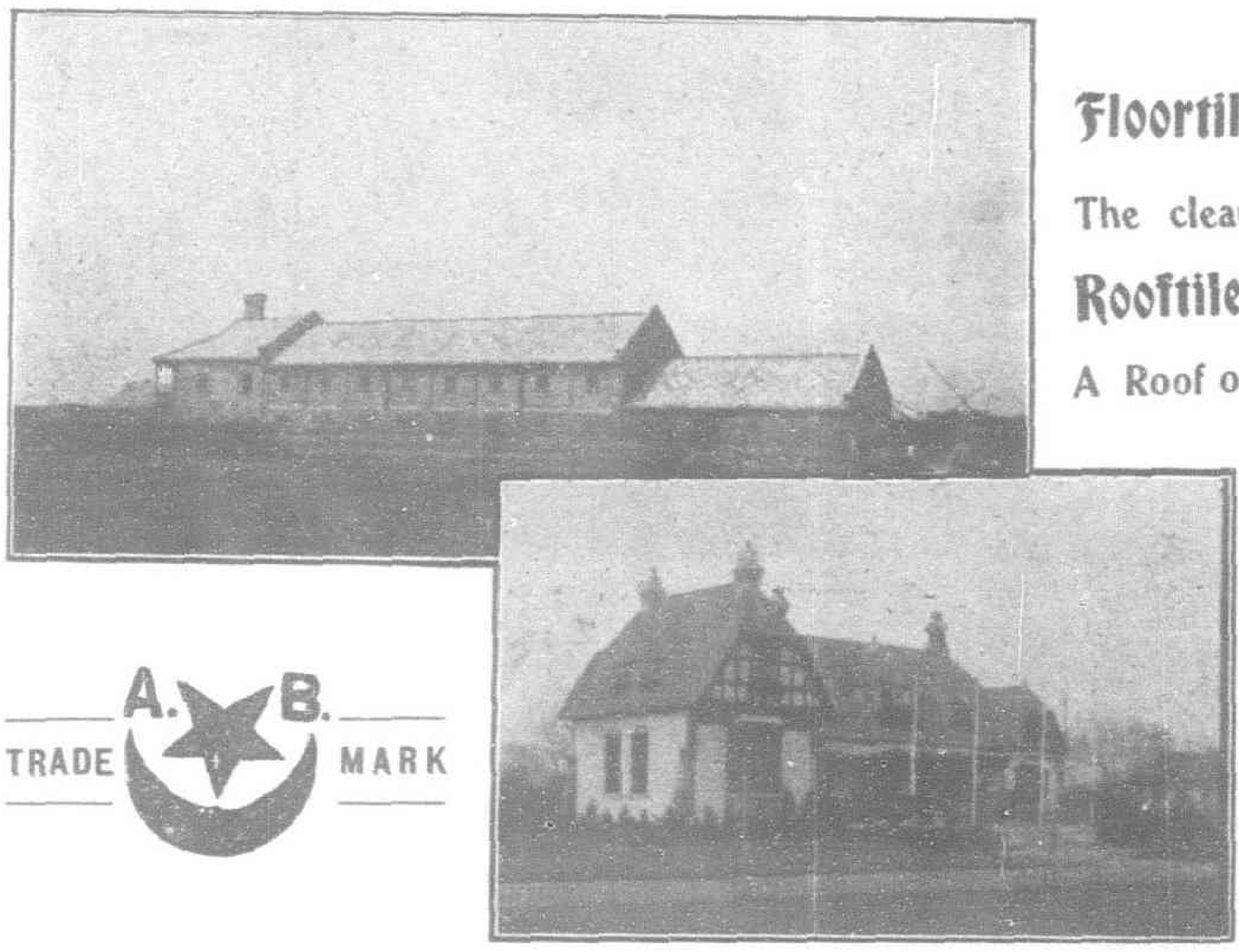

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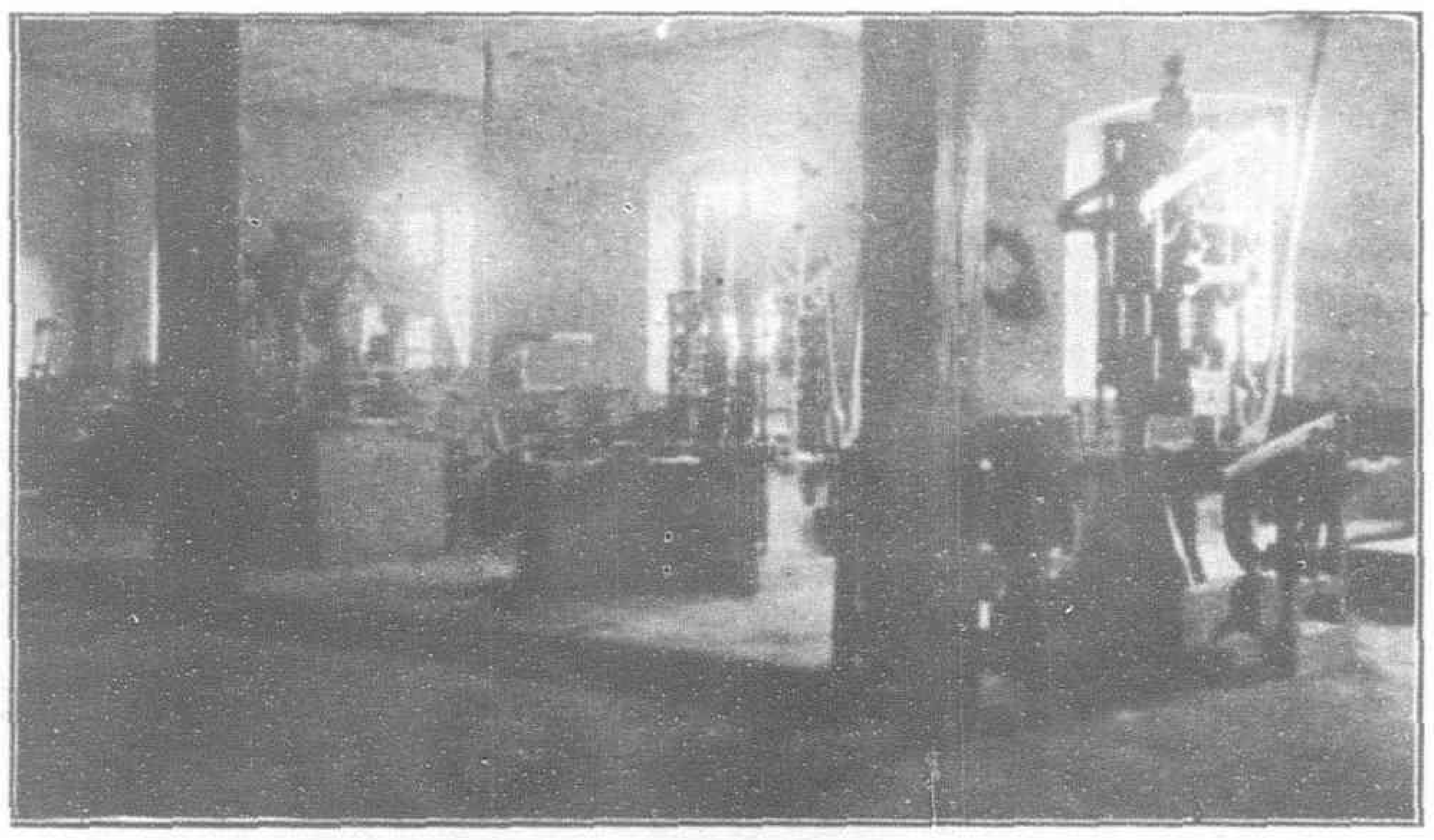

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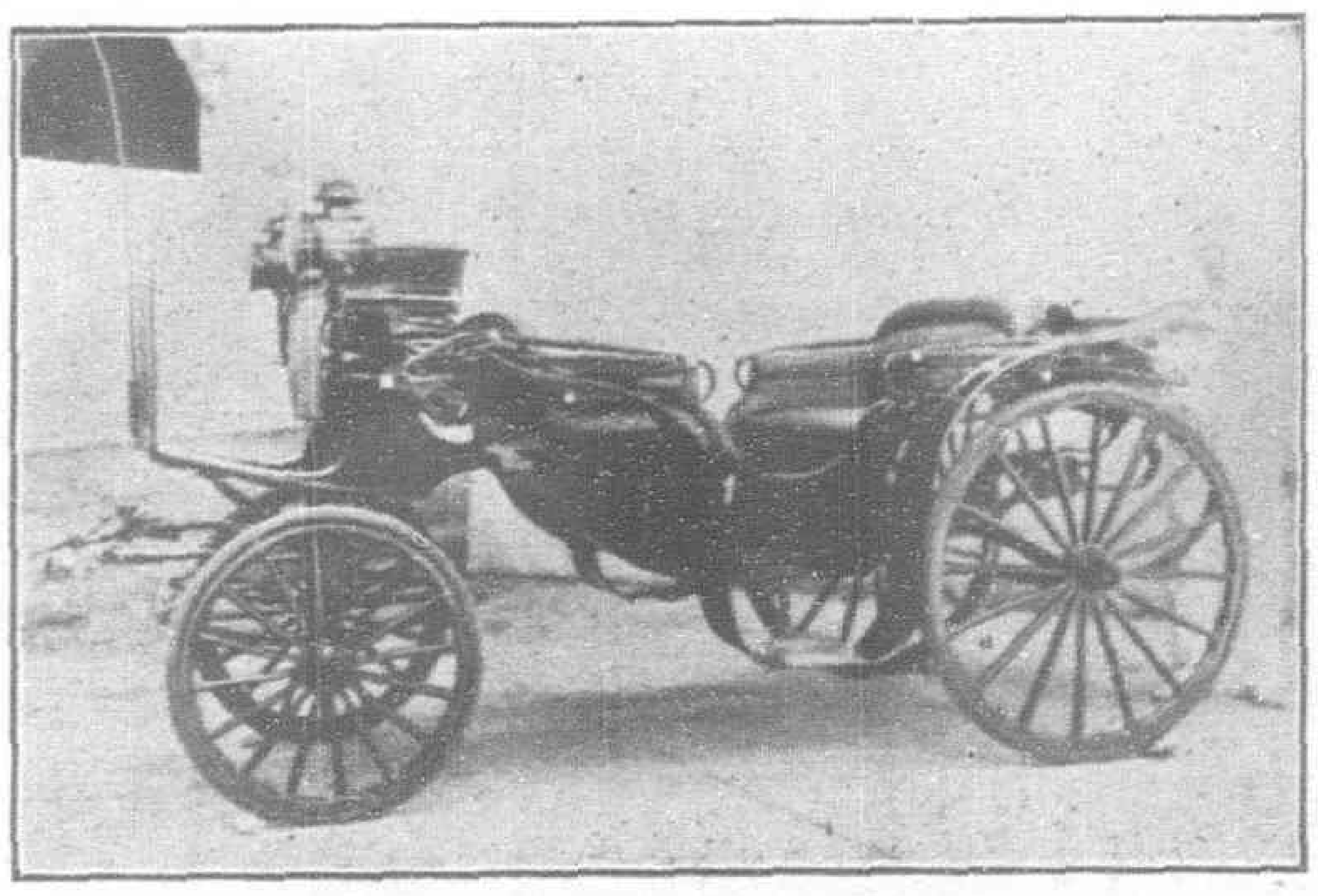

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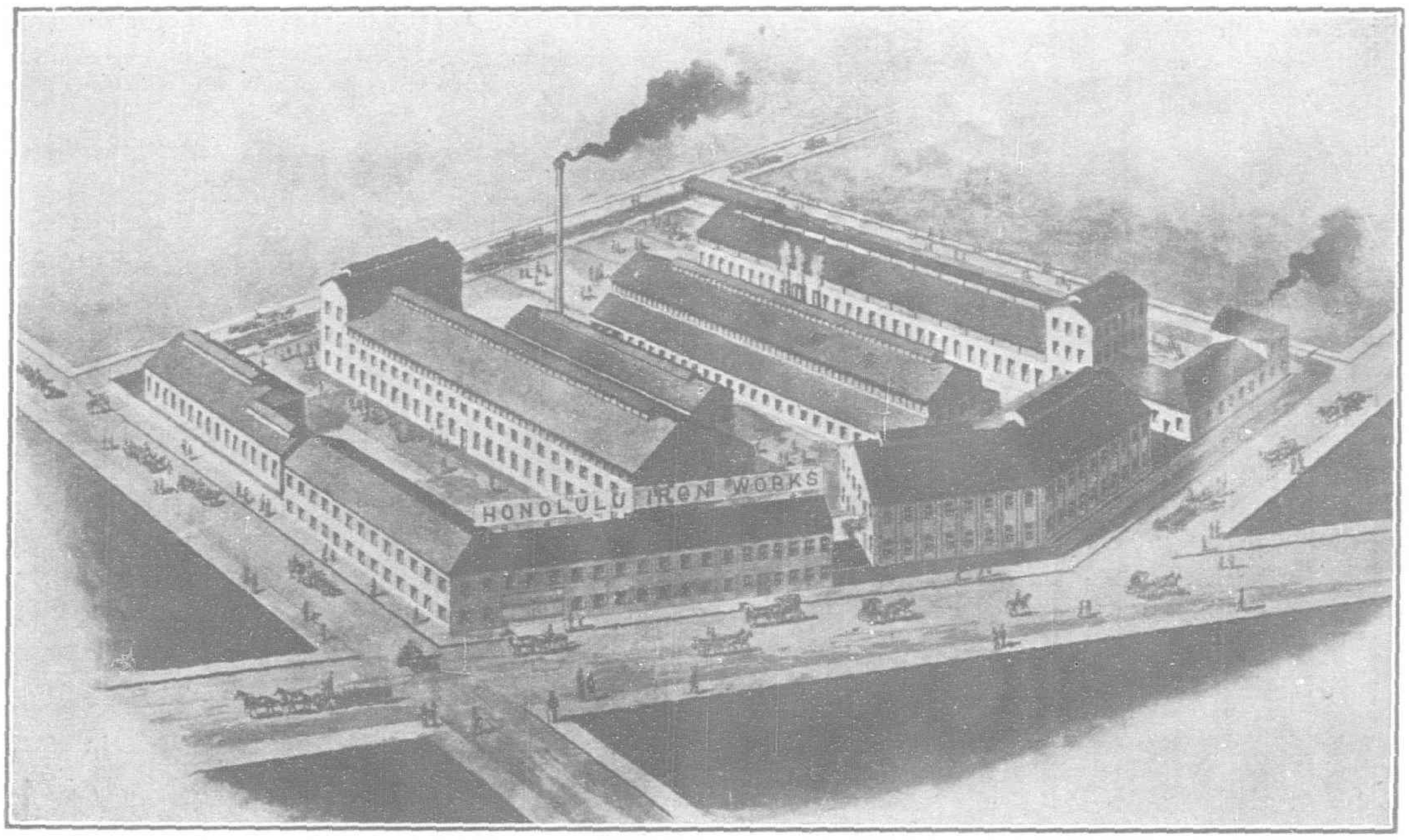

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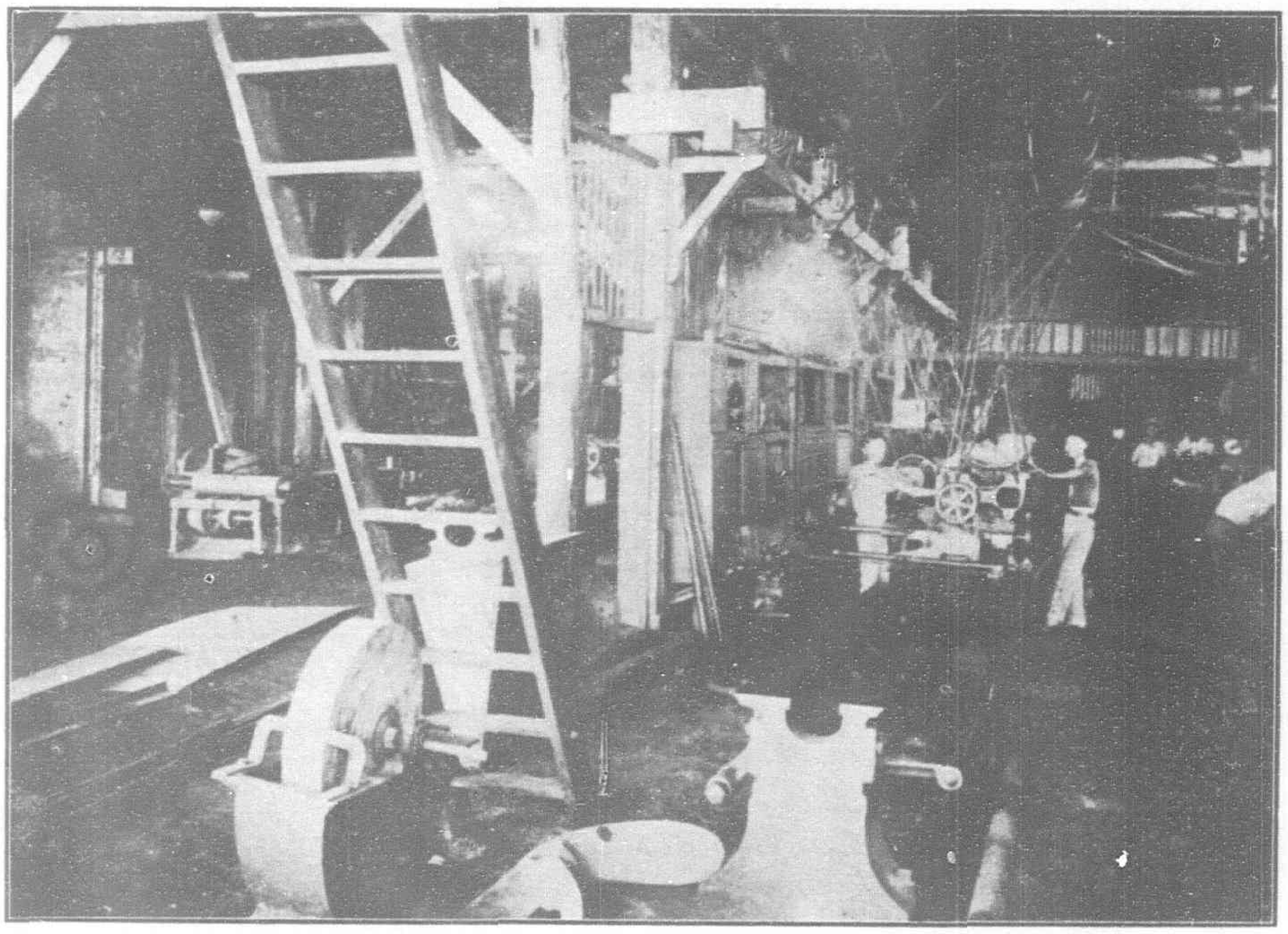

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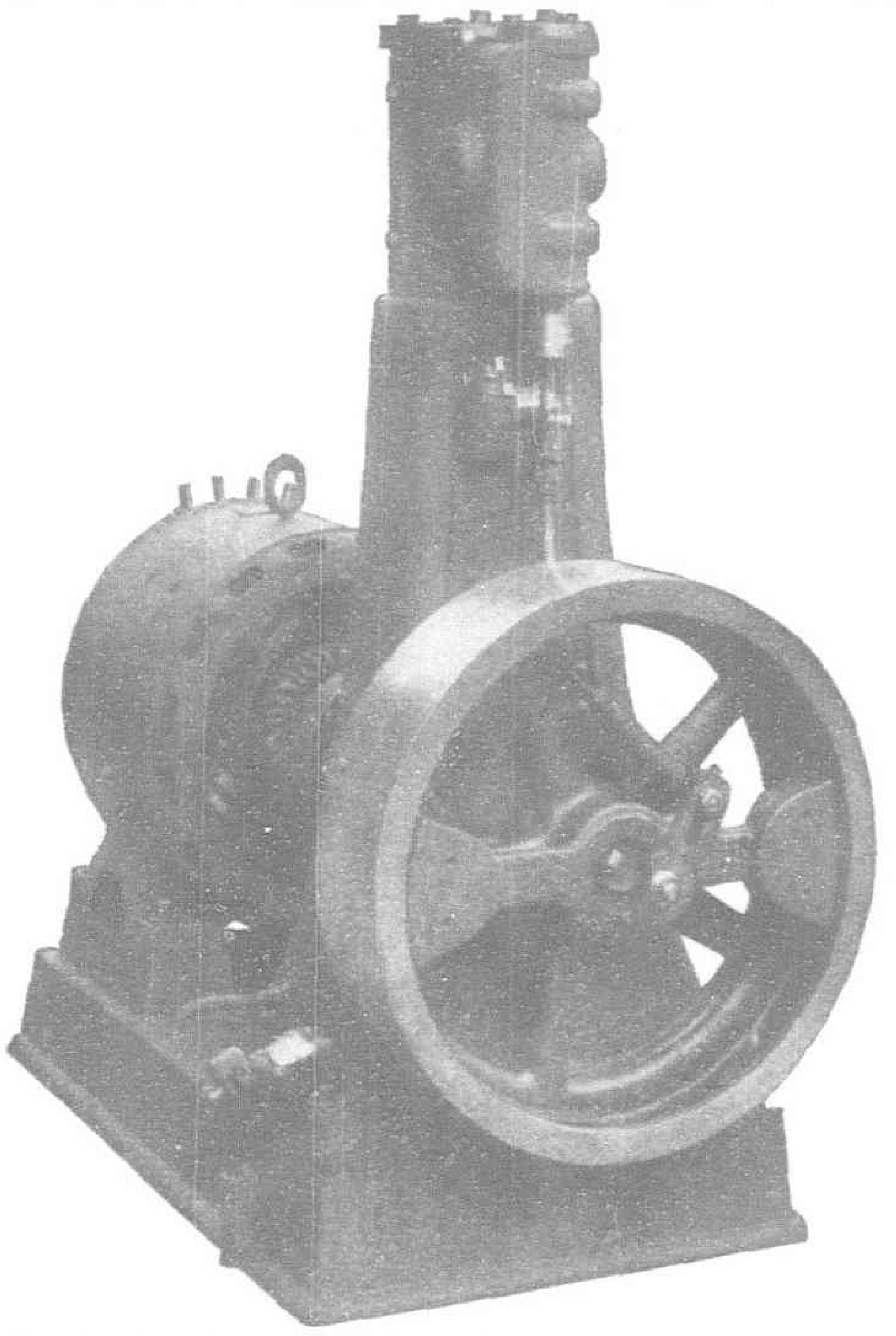

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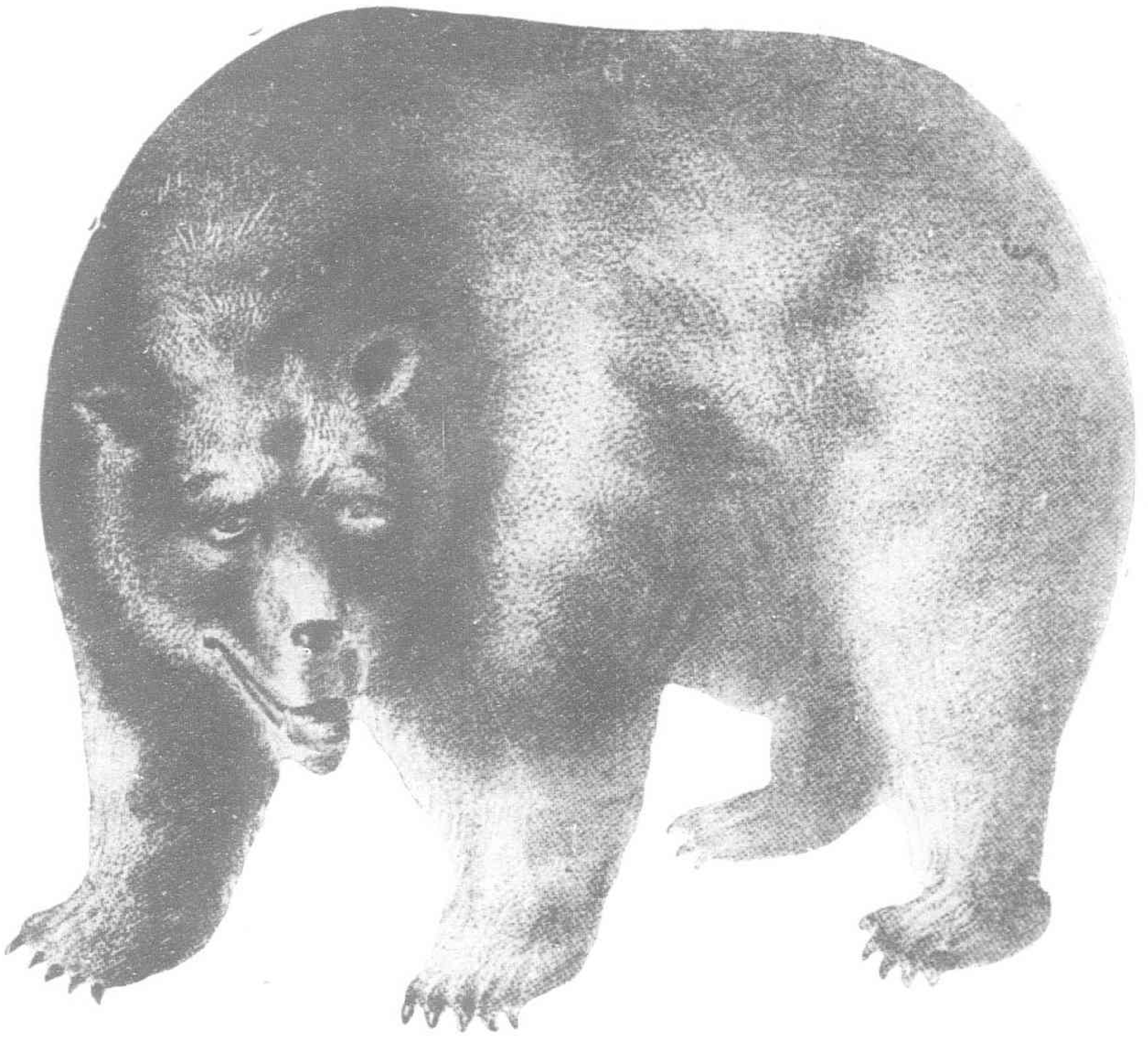

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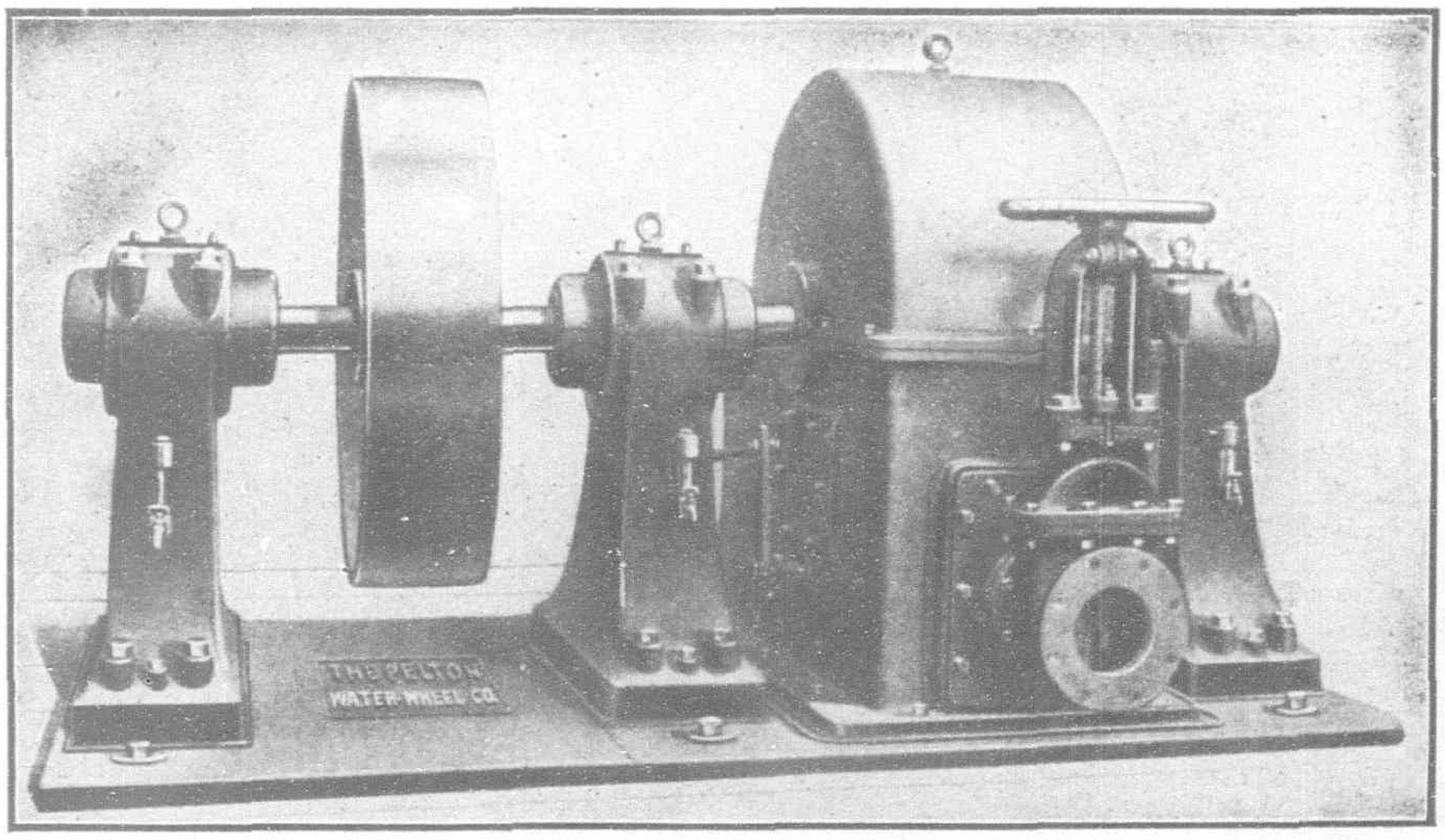

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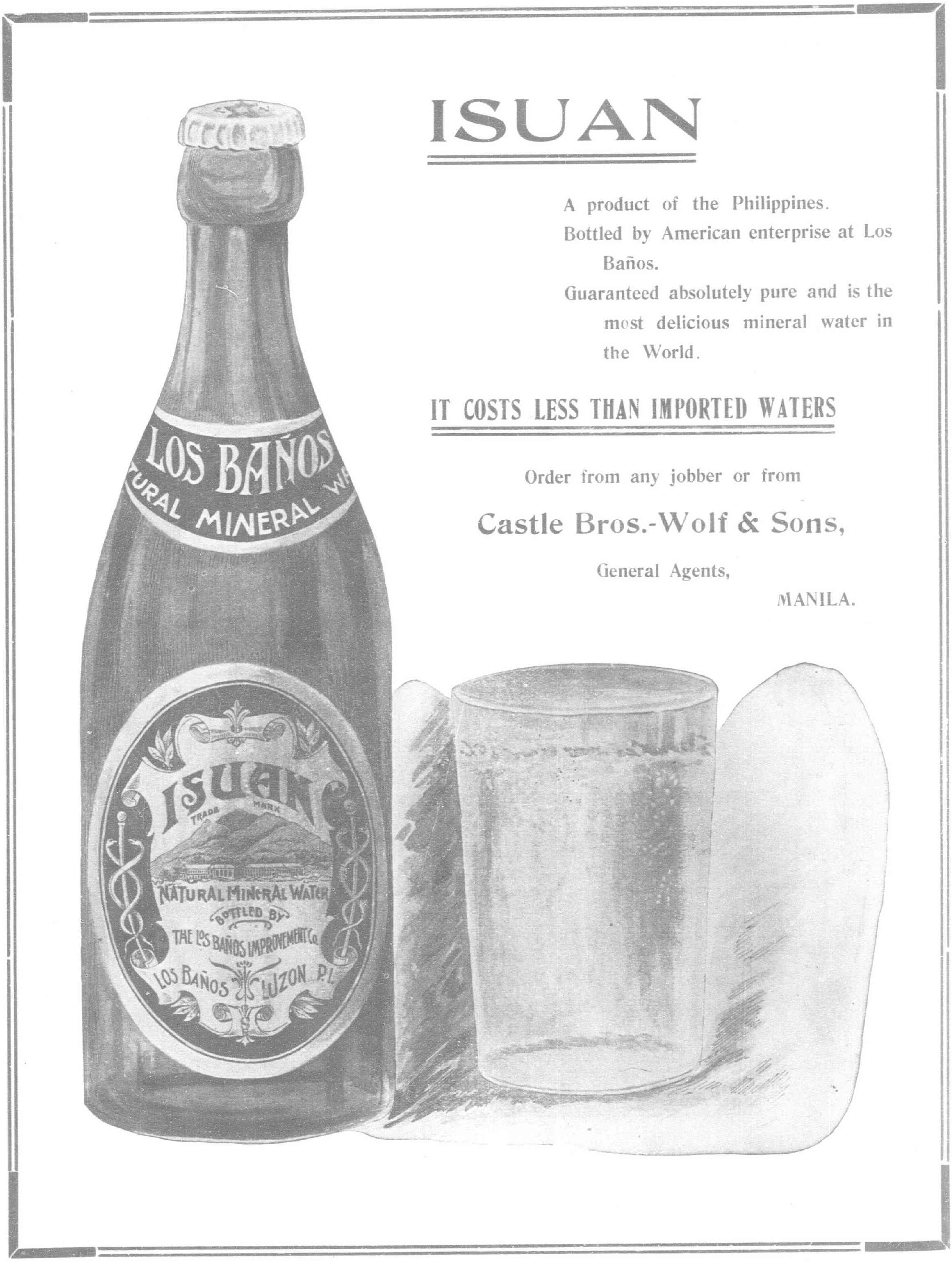

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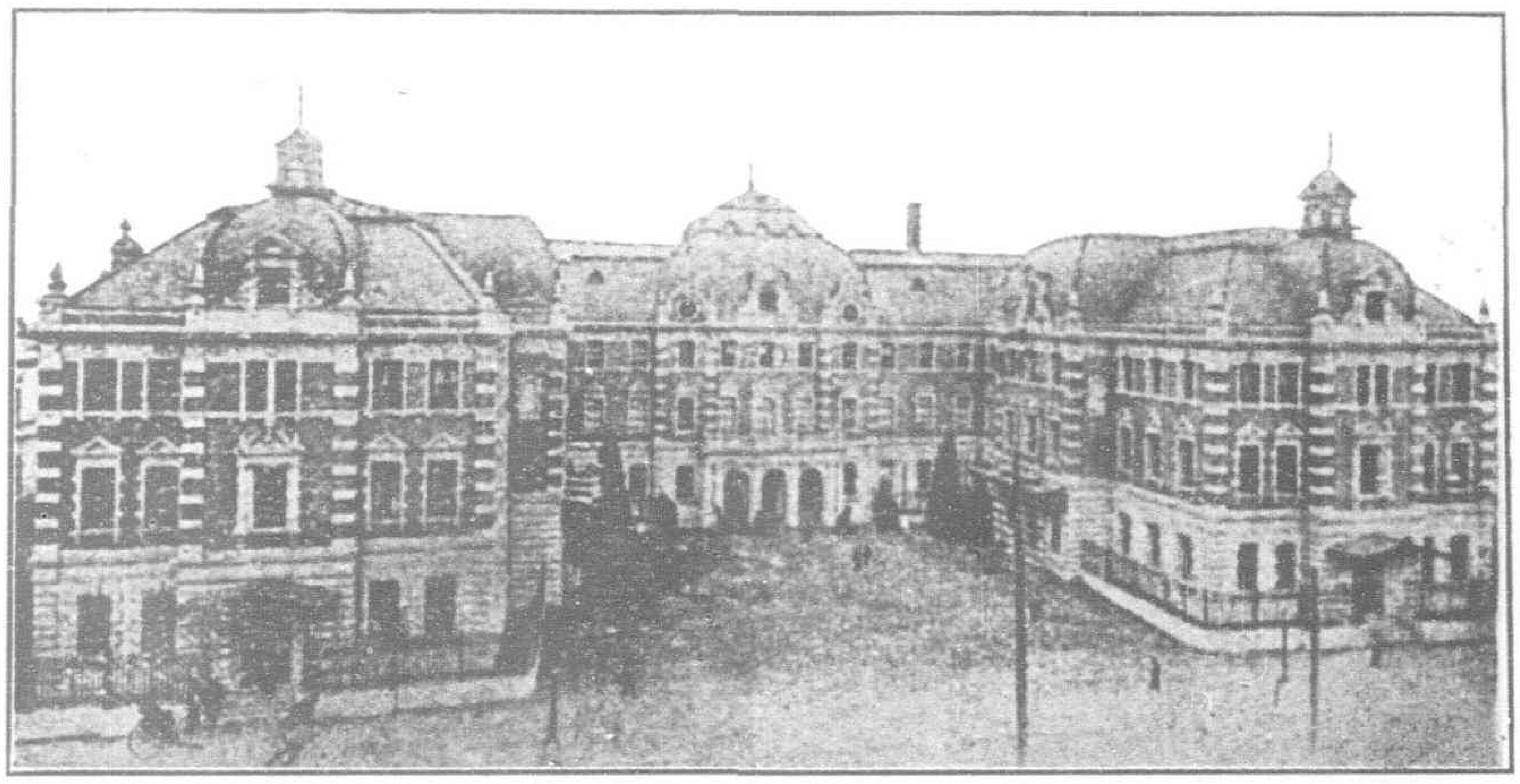

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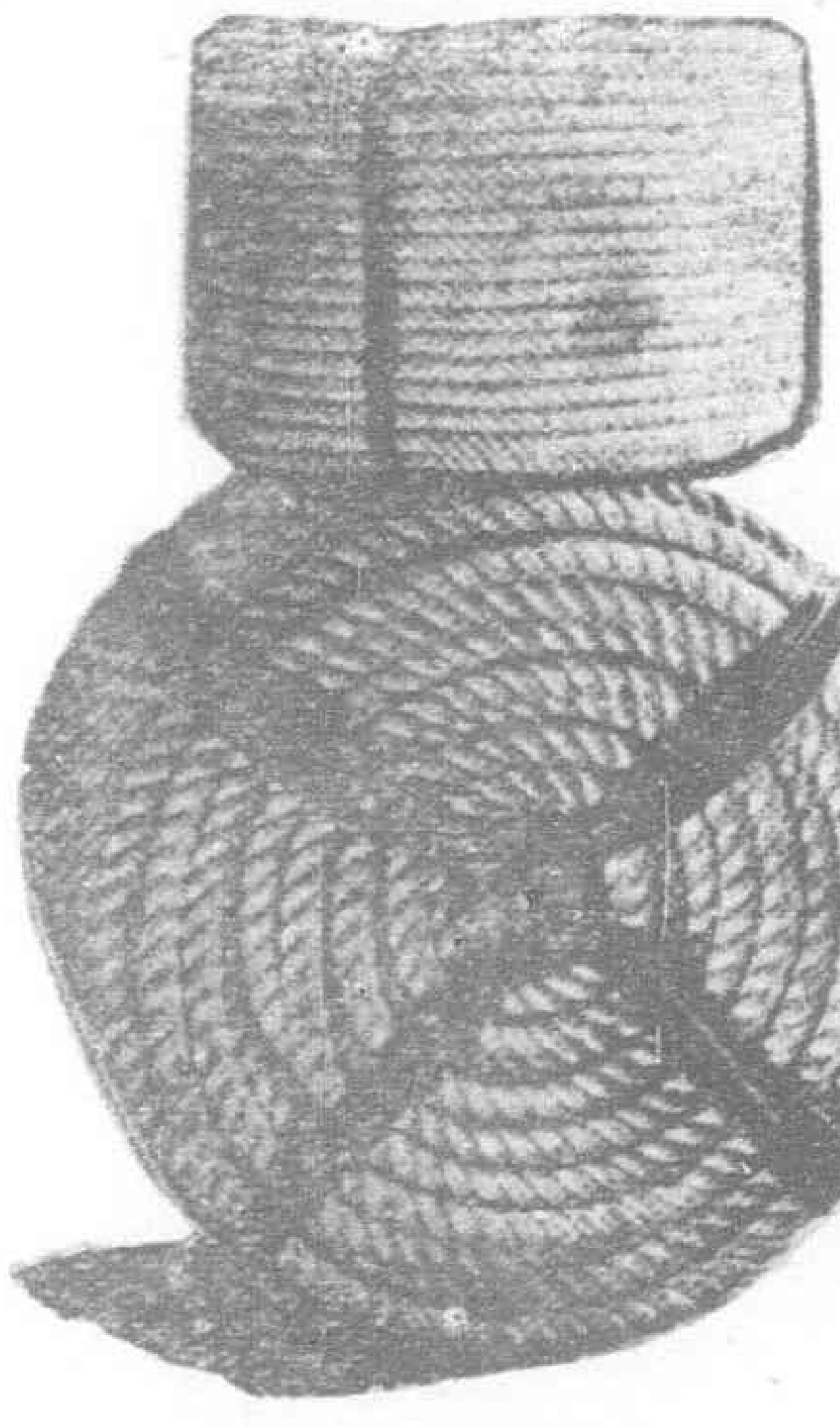

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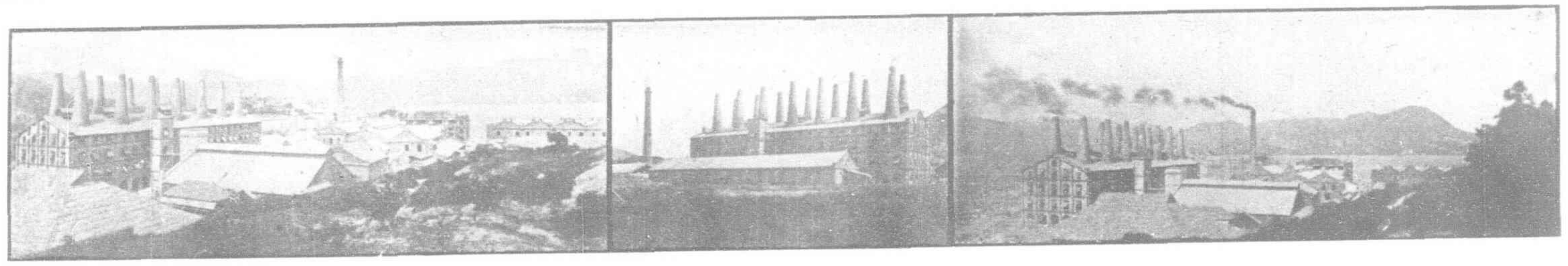

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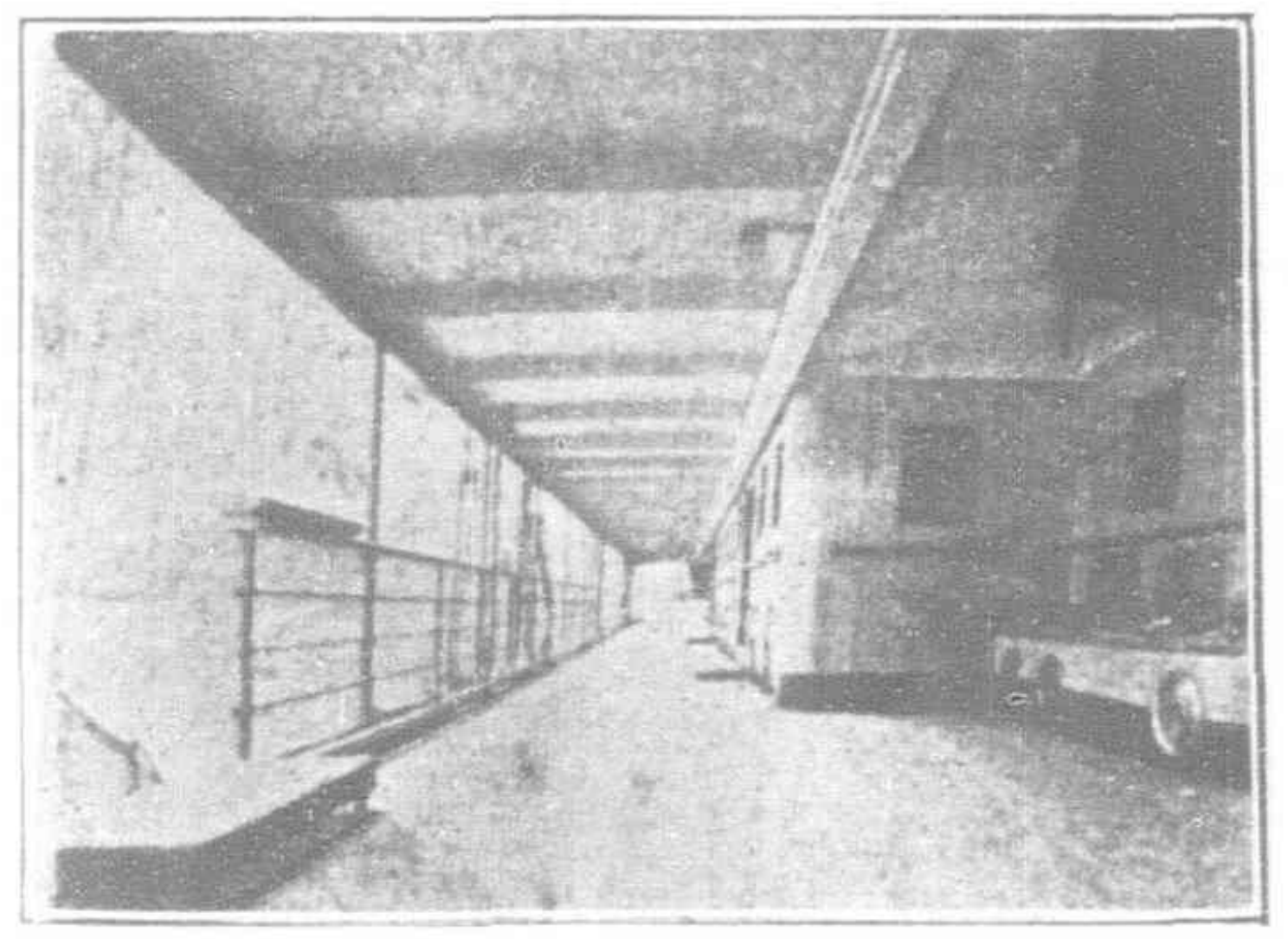

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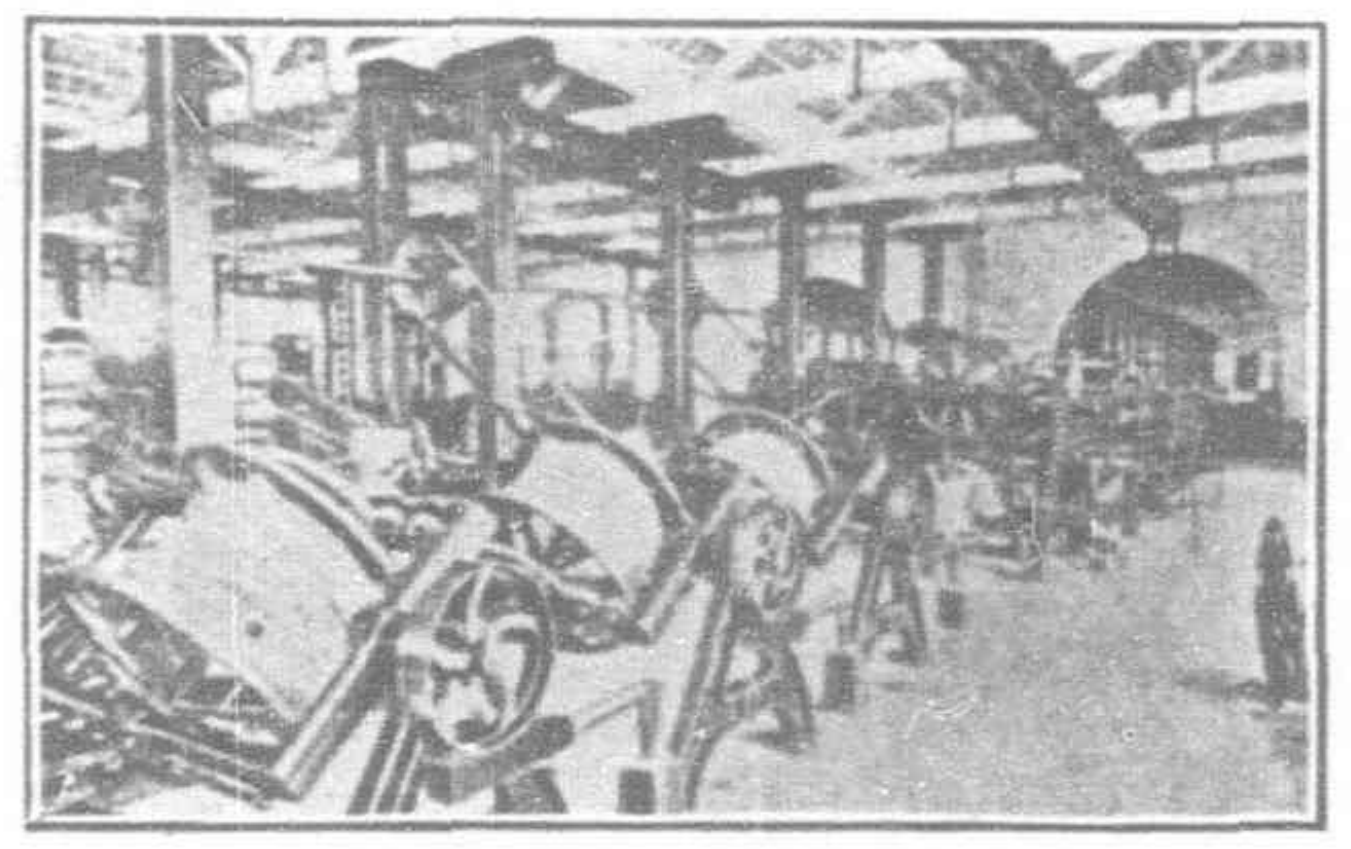

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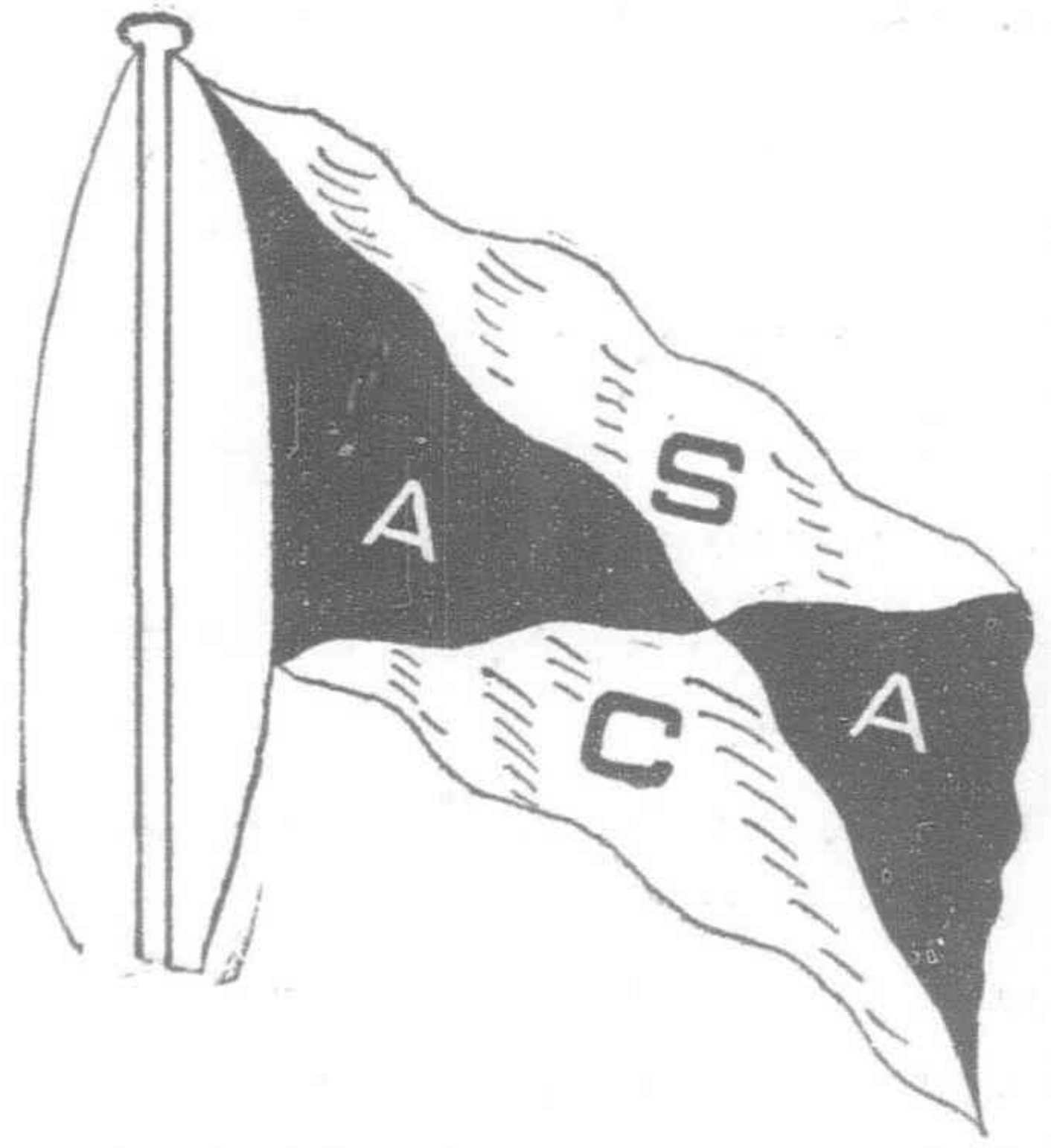

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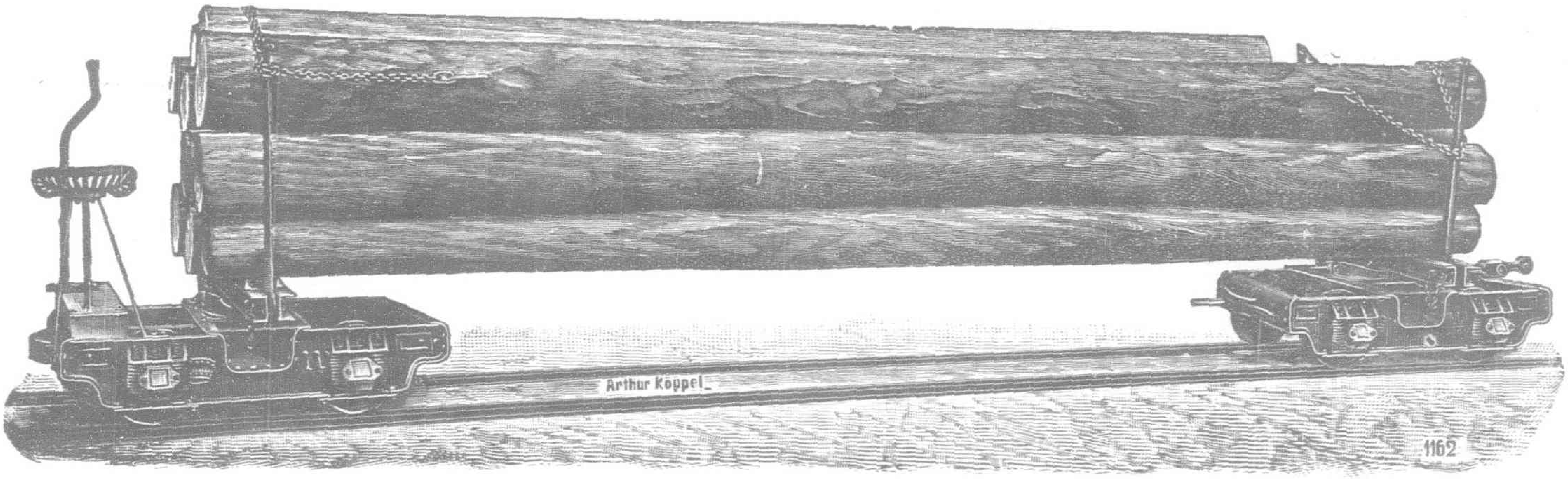

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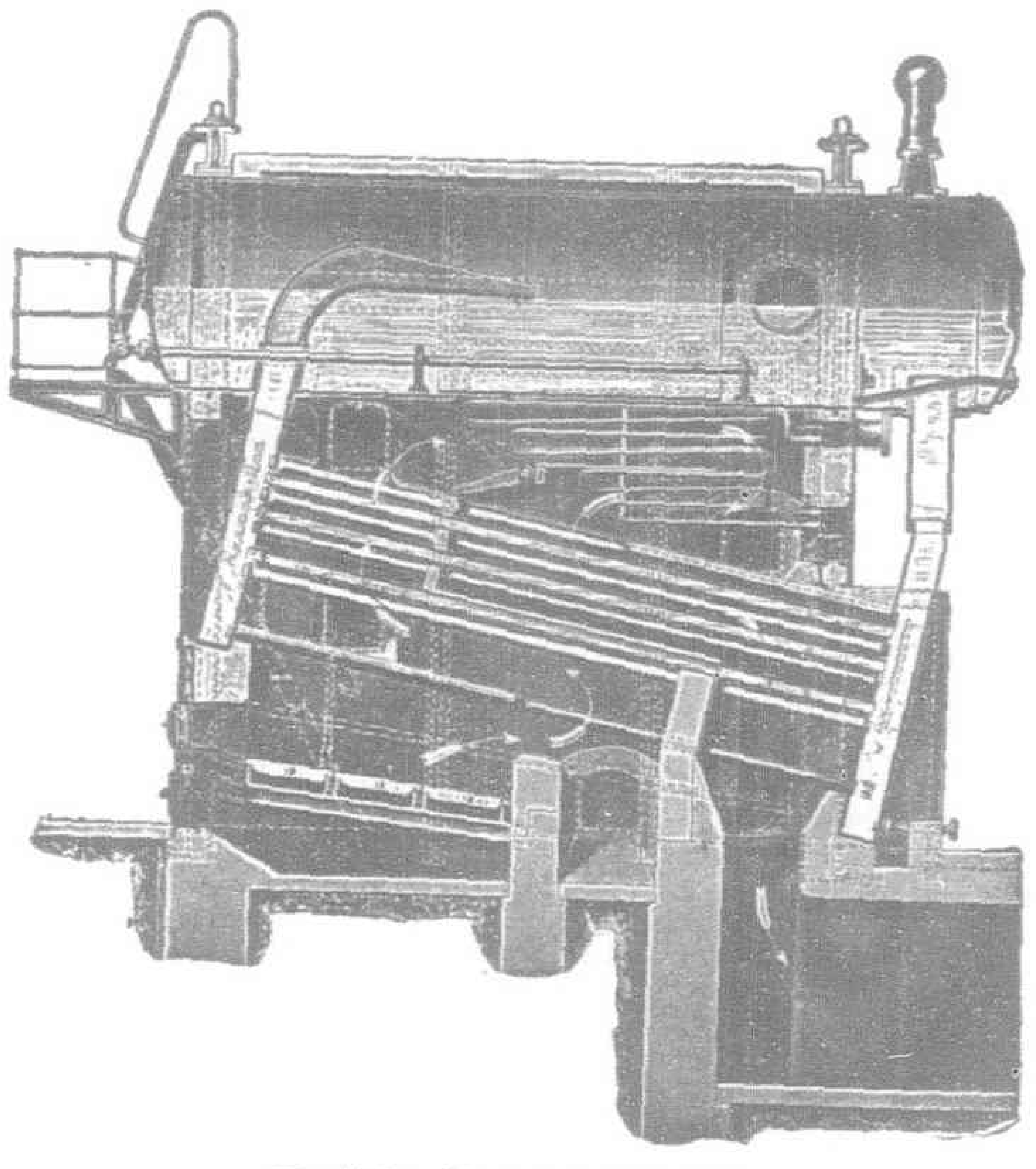

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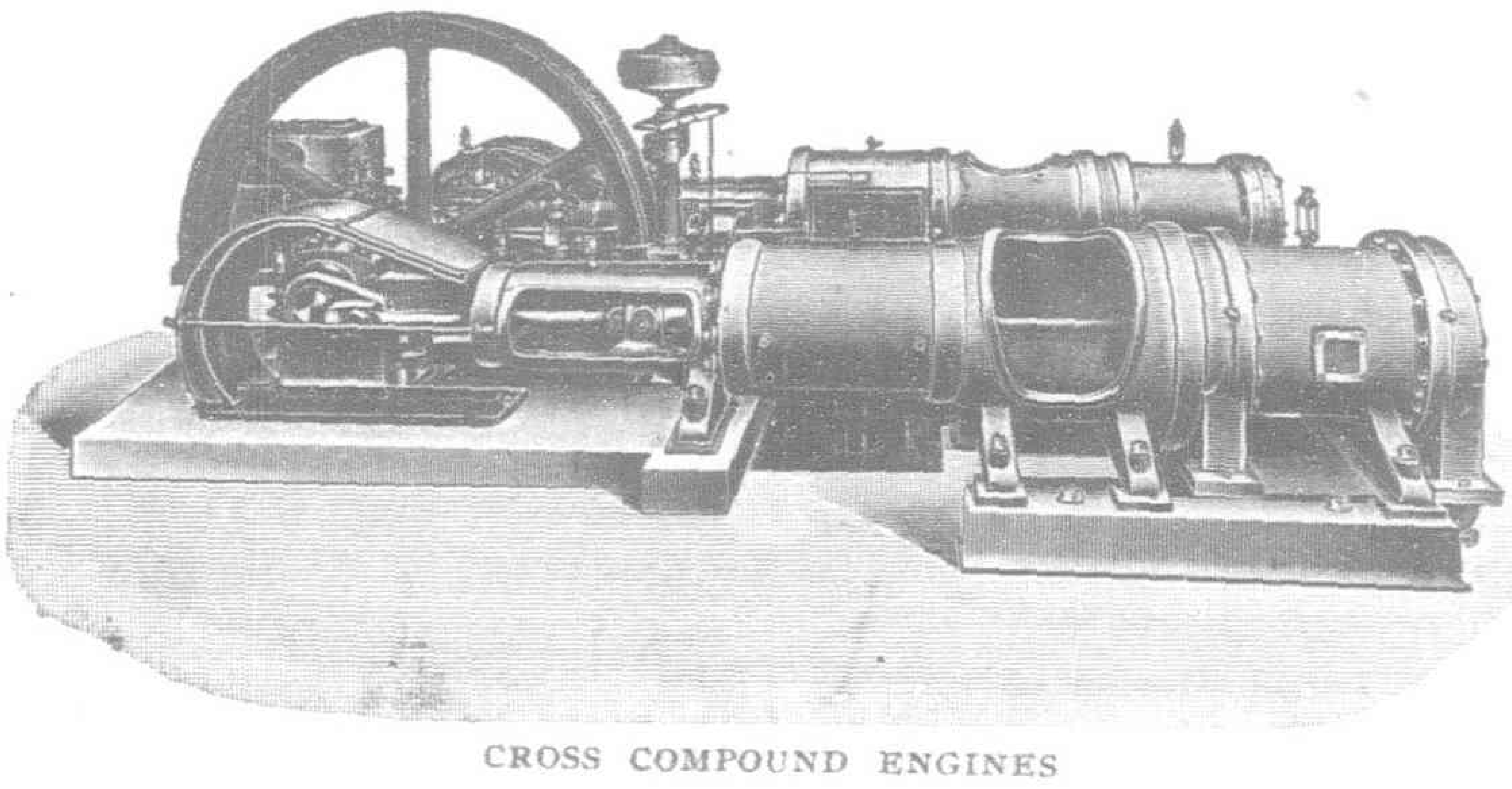

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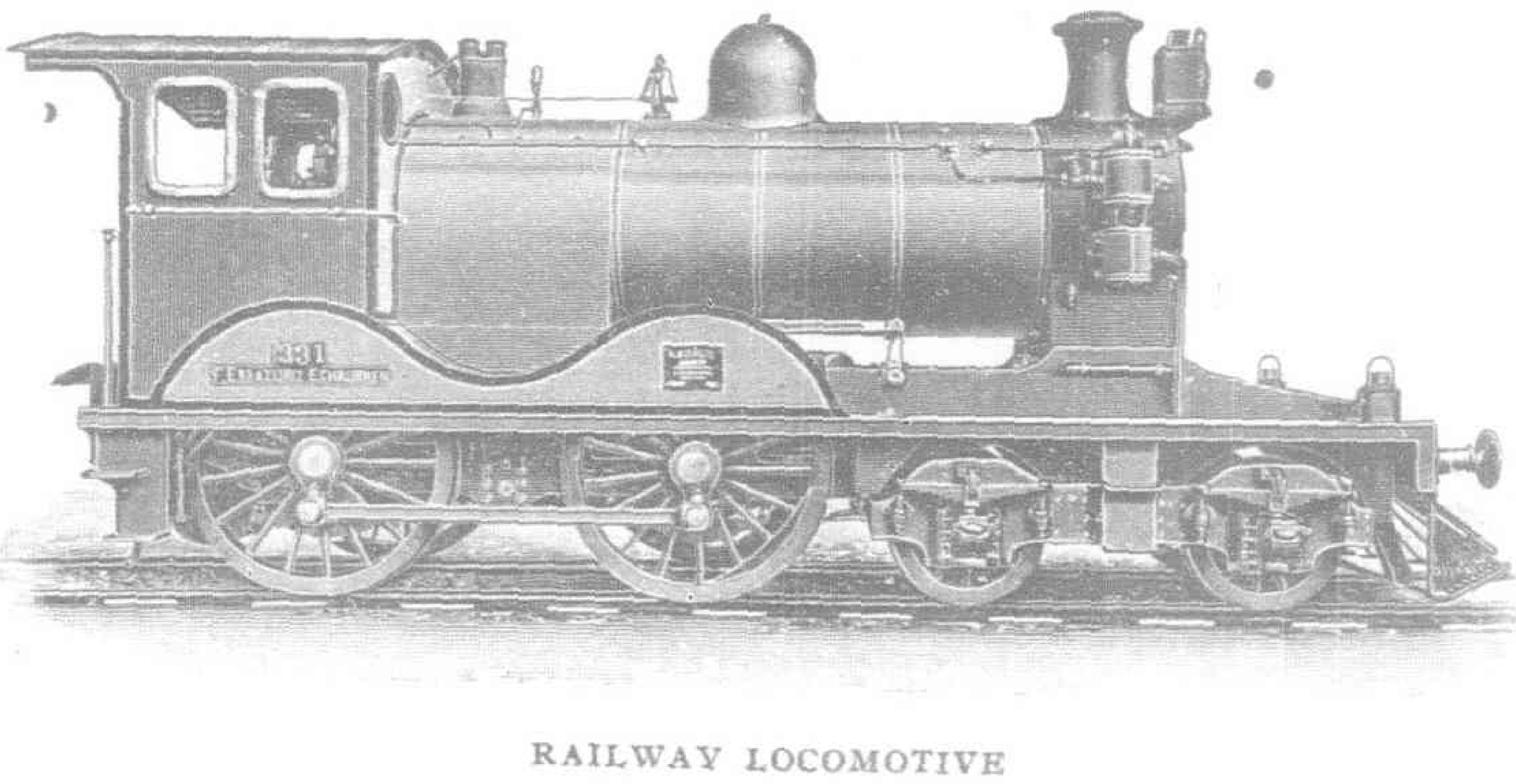

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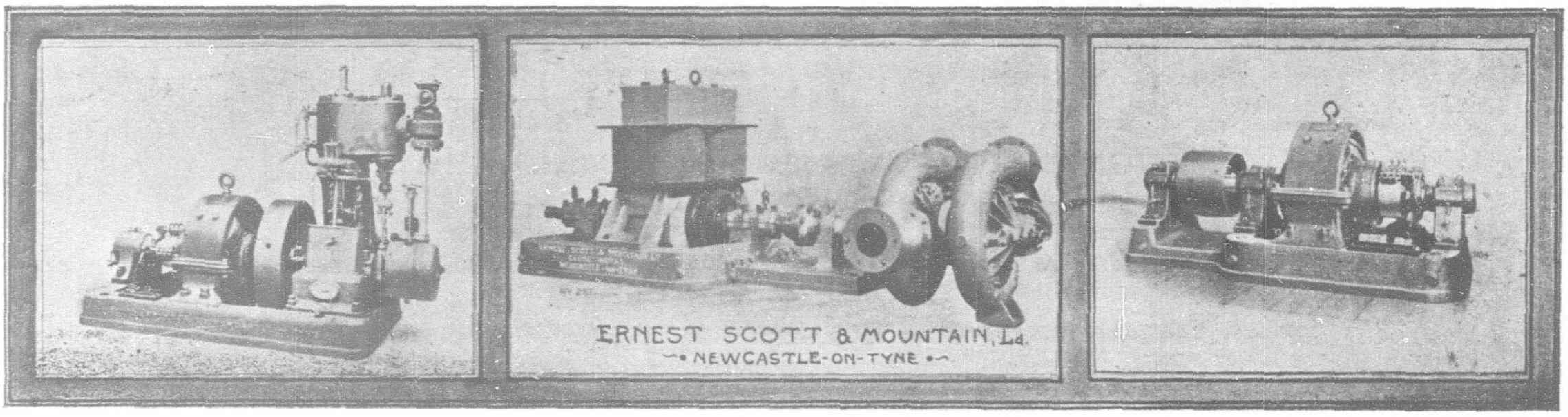

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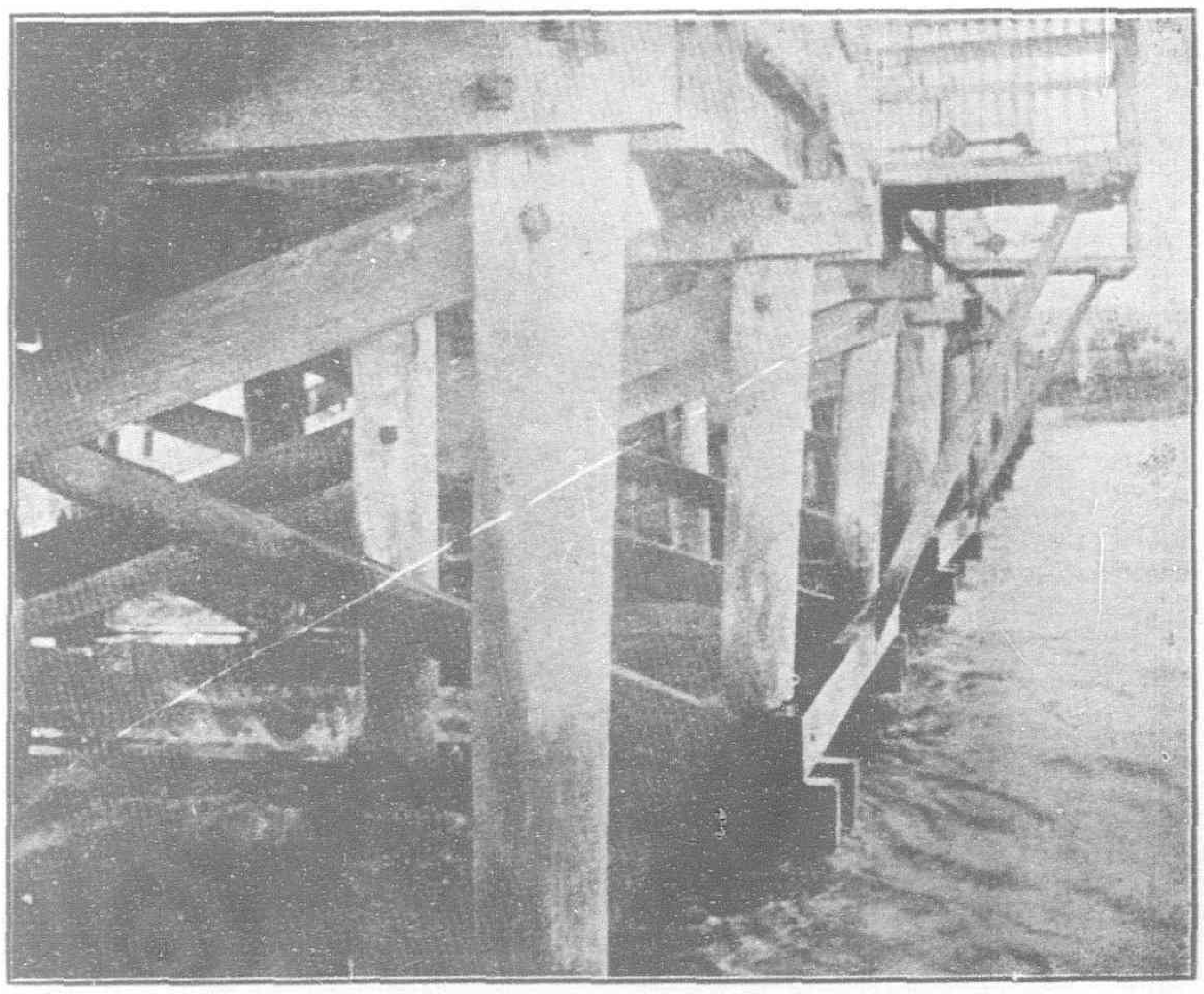

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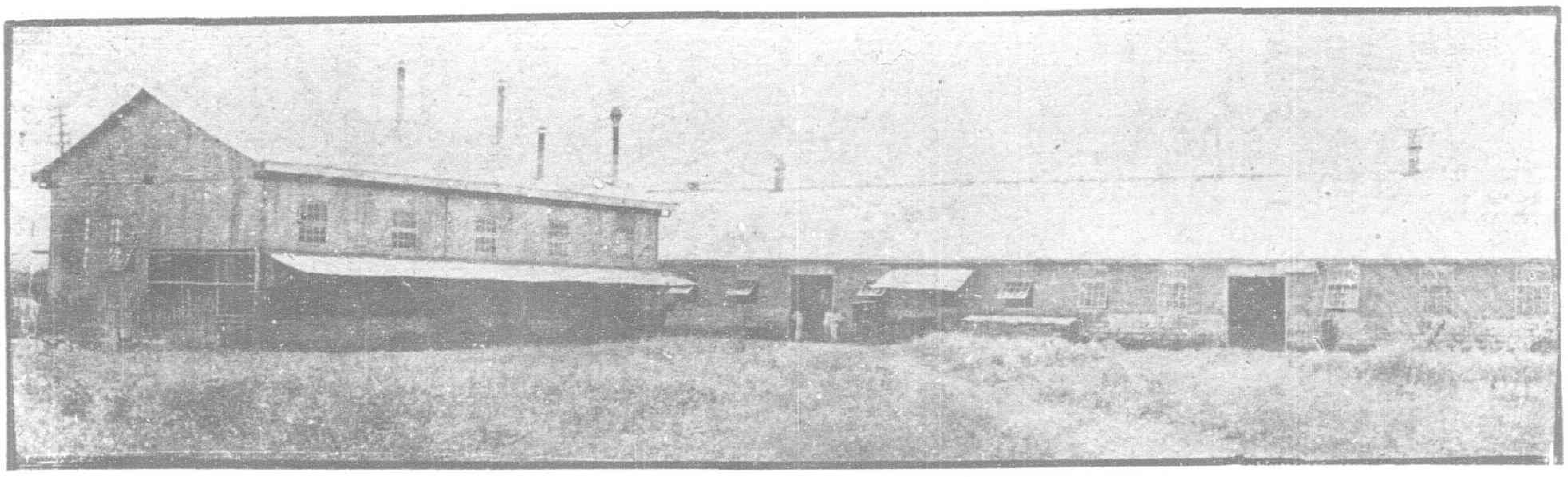

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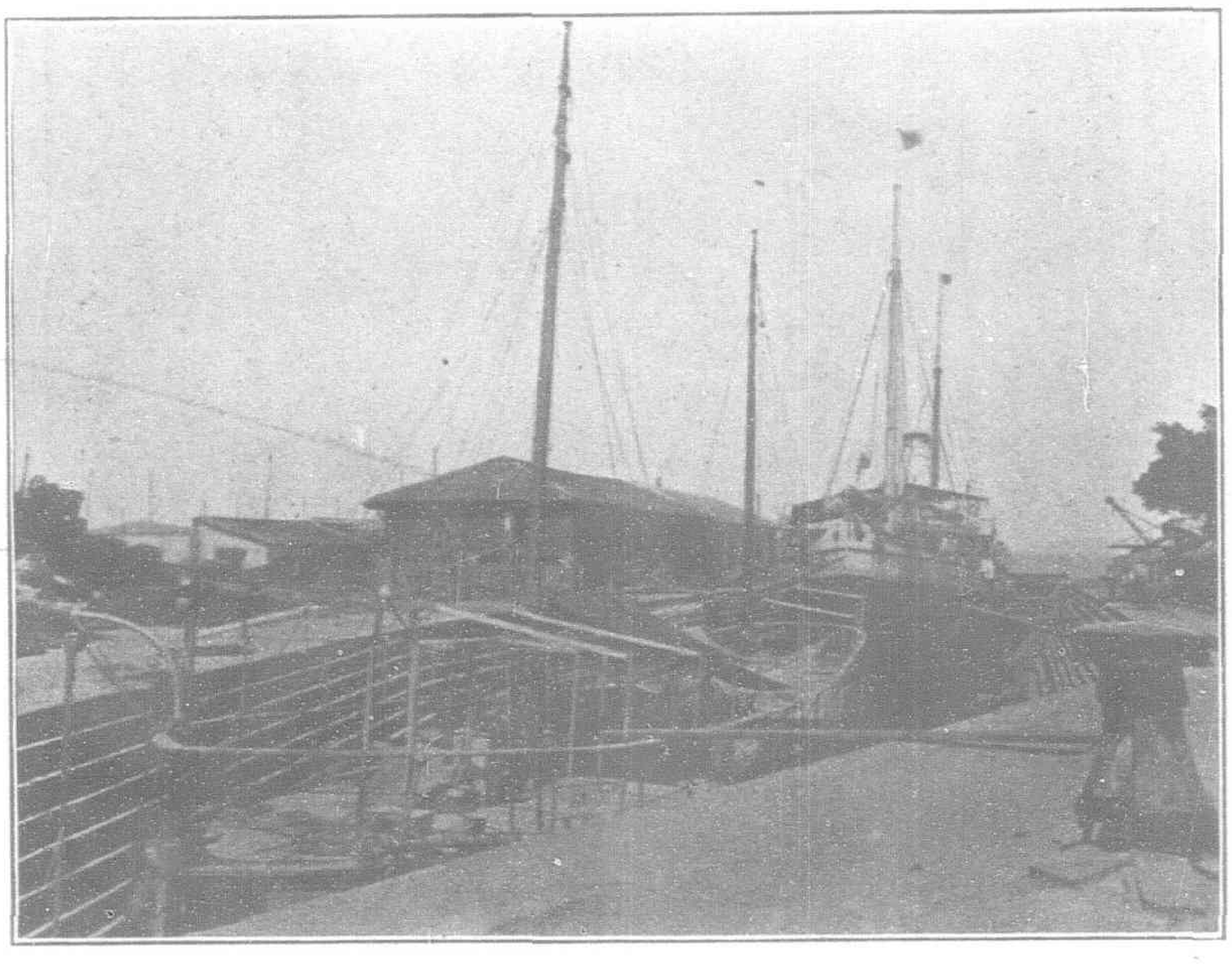

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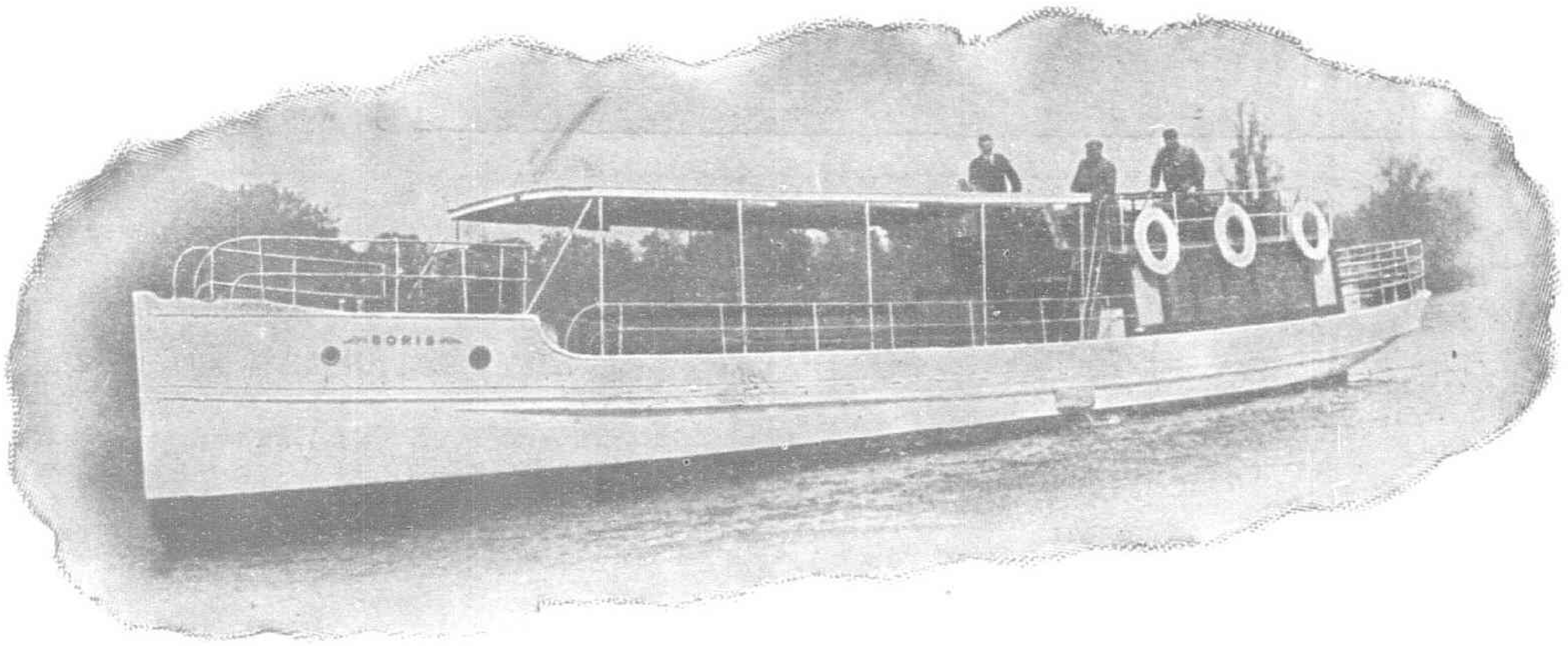

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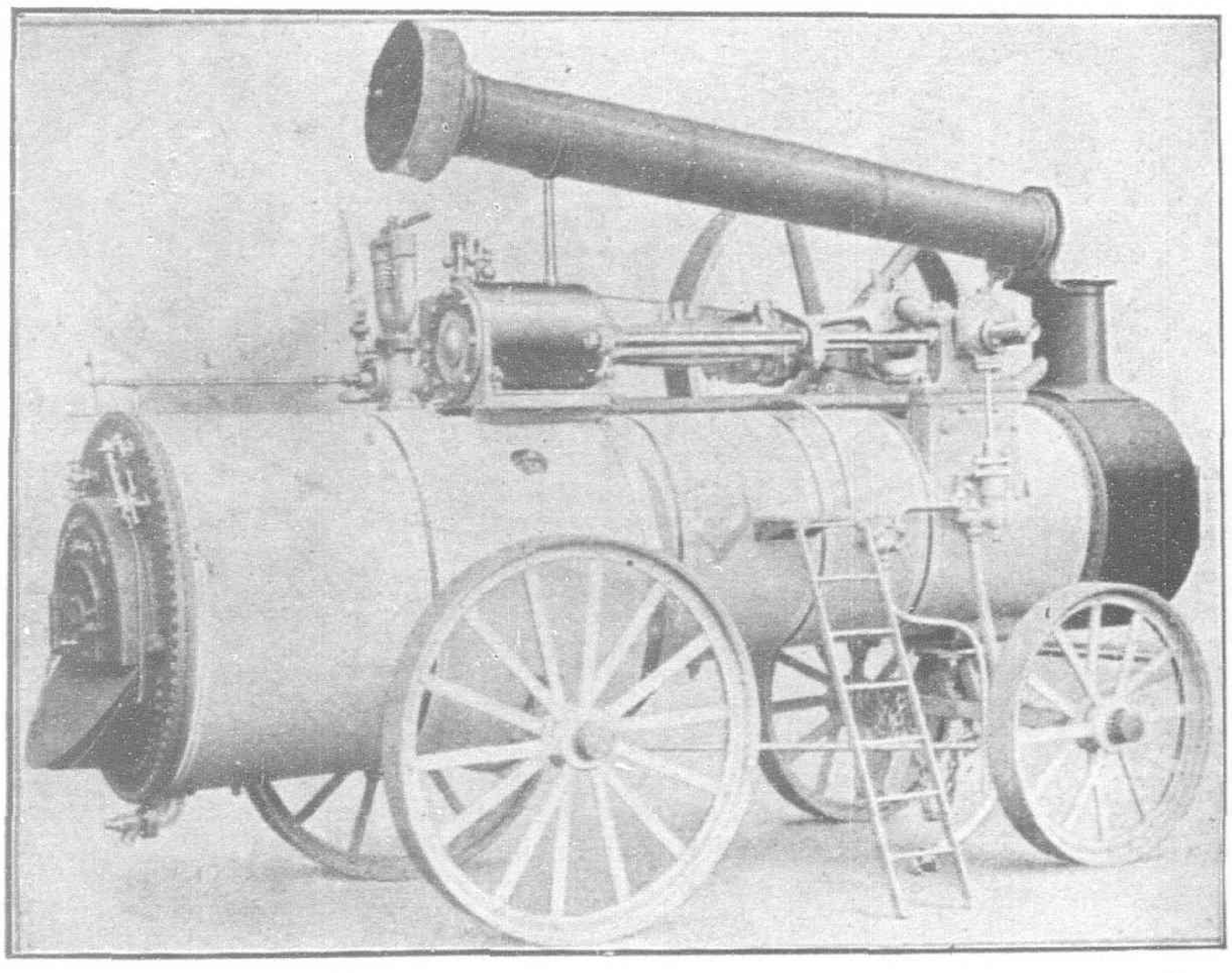

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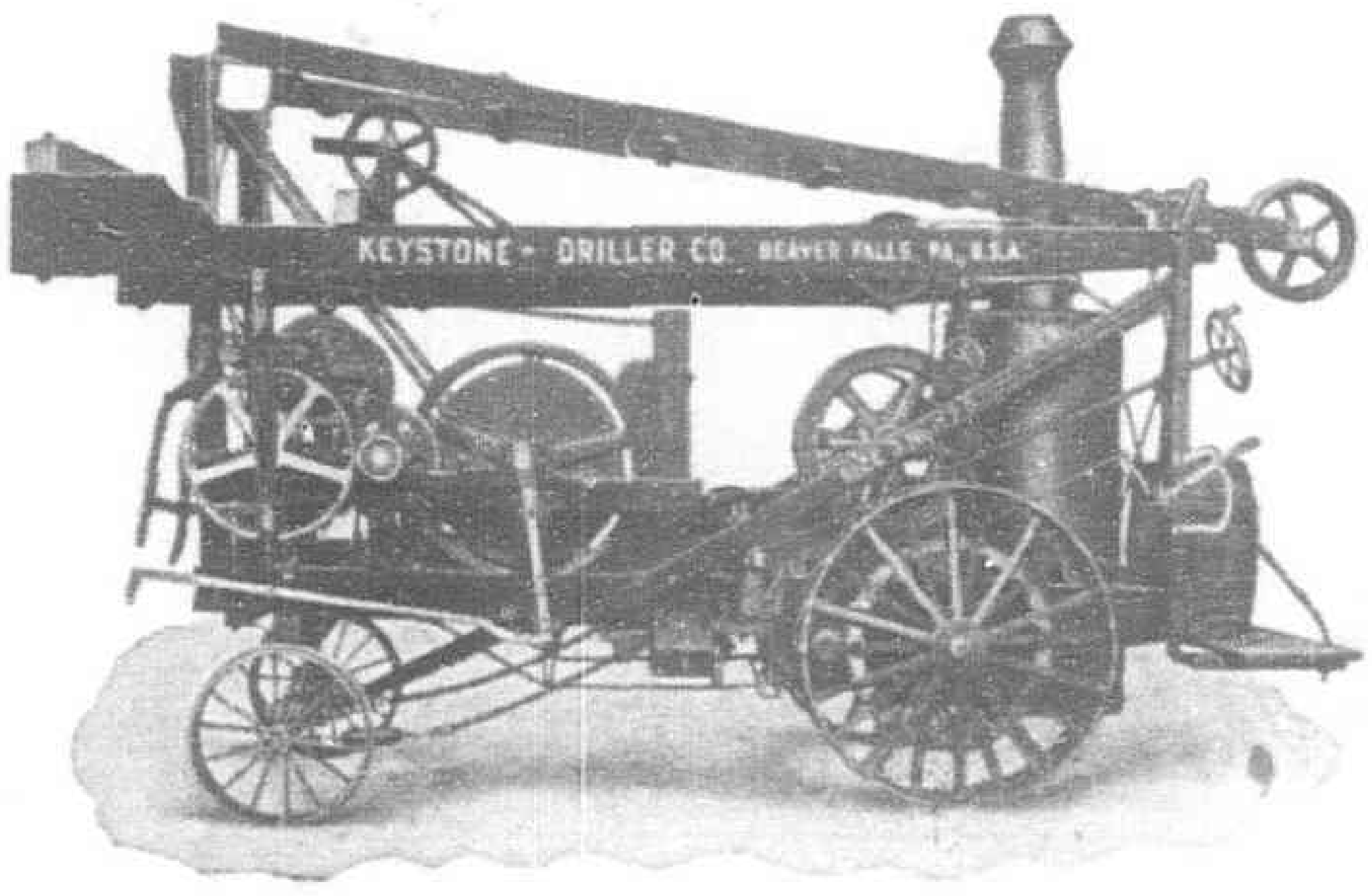

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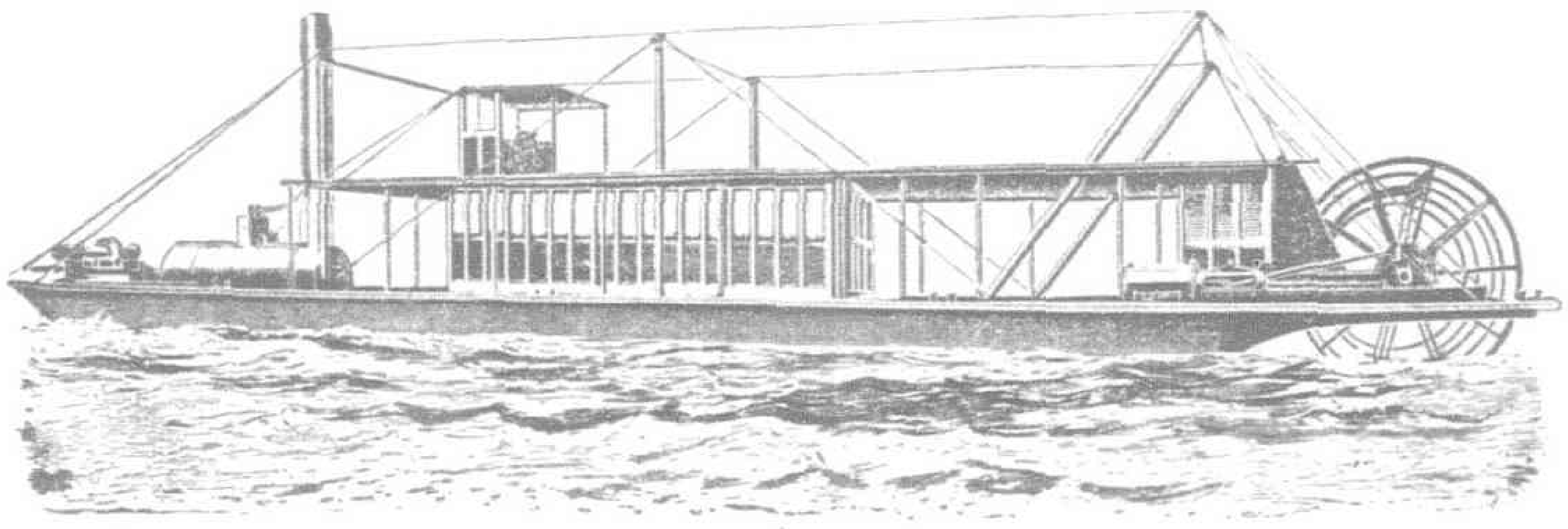

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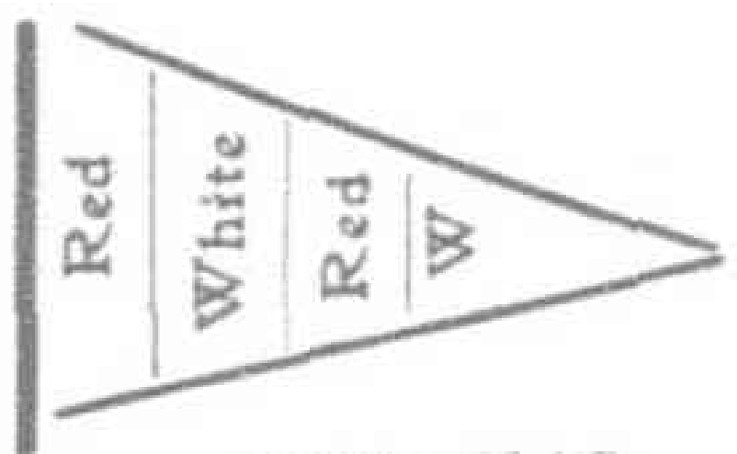

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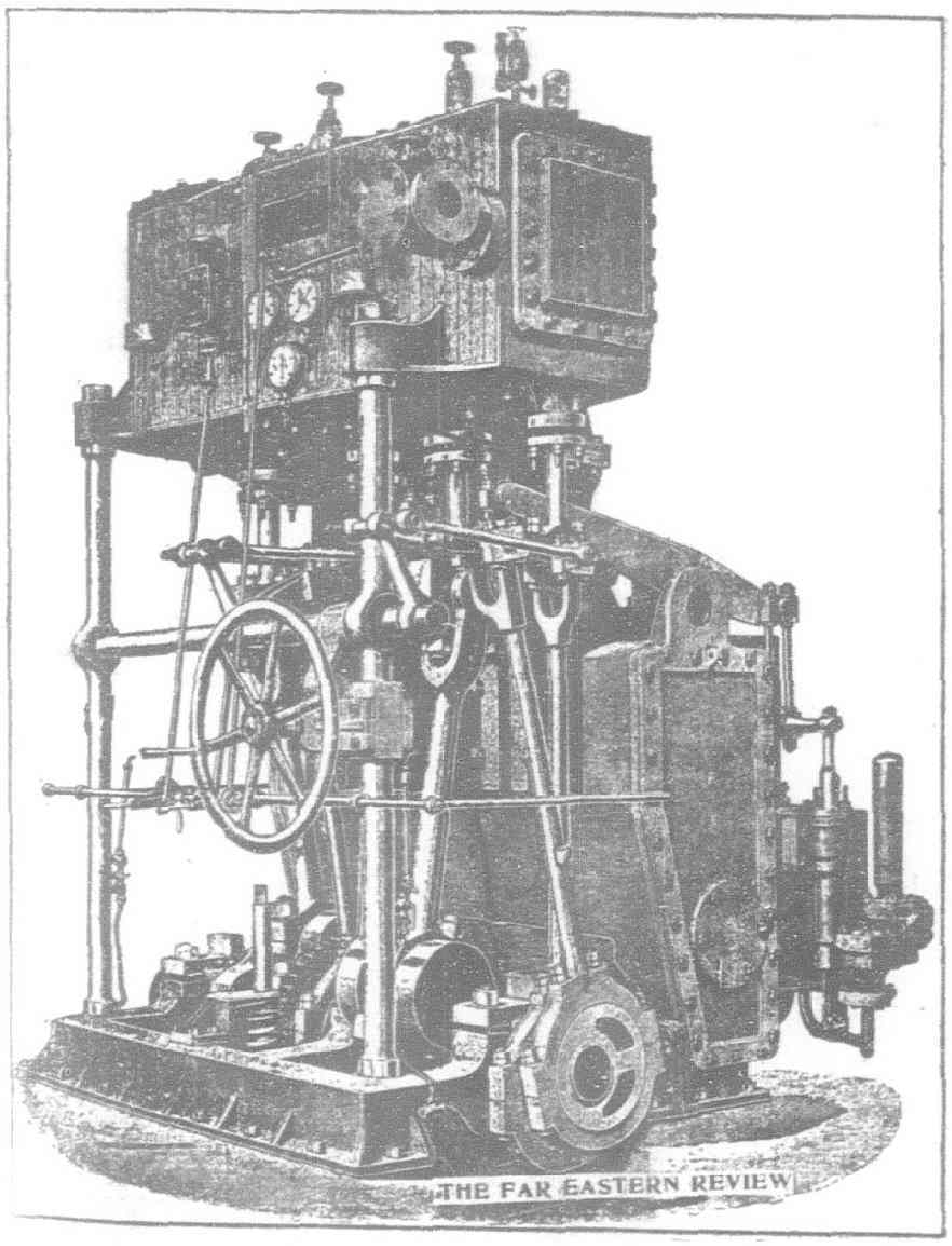

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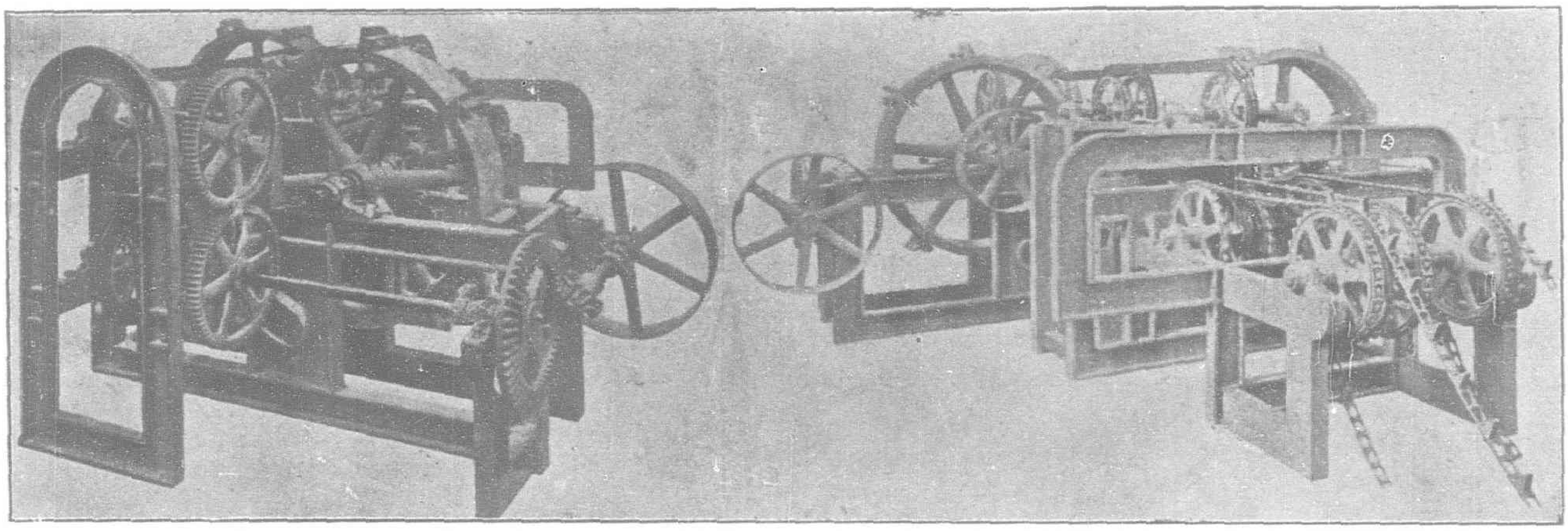

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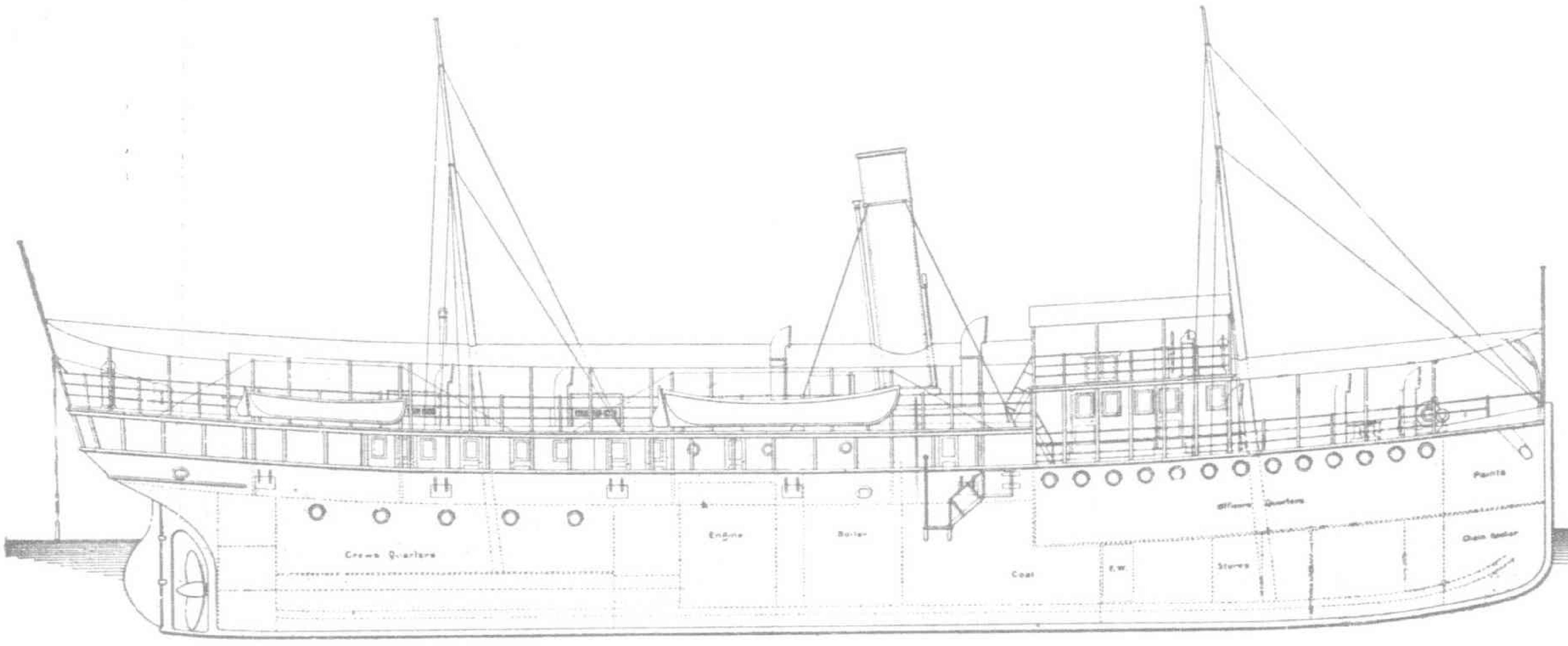
ENGINEERS, BOILERMAKERS, FOUNDERS, SHIP BUILDERS AND DOCK OWNERS

...HONGKONG...



U. S. COAST & GEODETIC SURVEY STEAMER "FATHOMER" BUILT BY THE HONGKONG AND WHAMPOA DOCK CO., LTD., FOR THE UNITED STATES GOVERNMENT, FOR SERVICE IN THE PHILIPPINES

THE COMPANY'S DOCKS at KOWLOON, TAI-KOK-TSUI and ABERDEEN are in efficient working order, and the attention of Captains and Shipowners is respectfully solicited to the advantages which these Establishments offer for Docking and Repairing Vessels.

The Company has SIX GRANITE DOCKS and TWO PATENT SLIPS of the following dimensions:—

NAME OF DOCK OR SLIP	LENGTH ON KEEL BLOCKS	BREADTH AT ENTRANCE	DEPTH OVER SILL AT ORDINARY SPRING TIDES	RISE OF TIDE	
				SPRINGS	NEAPS
KOWLOON	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
No. 1 Dock, Kowloon	576	86 feet top 70 ft. bottom	30′	7′ 6″	3
No. 2 Dock, Kowloon	371	74′	18′ 6″	7′ 6″	—
No. 3 Dock, Kowloon	264	49′ 3″	14′	7′ 6″	—
Patent Slip, No. 1, Kowloon	240	60′	14′	7′ 6″	—
Patent Slip, No. 2, Kowloon	220	60′	12′	7′ 6″	—
TAI-KOK-TSUI					
Cosmopolitan Dock	466	85′ 6″	20′	7′ 6″	—
ABERDEEN					
Hope Dock	430	84′	23′	7′ 6″	—
Lamont Dock	333	64′	16′	7′ 6″	—

The DOCKS are fitted with every appliance in the way of Caissons powerful Centrifugal Steam Pumps, etc., which enable them to be pumped out in three hours.

WORKSHOPS.—The extensive workshops on the premises at Kowloon, Cosmopolitan, and Aberdeen Docks possess every facility and appliance necessary for the repairs of ships and steam machinery. The Engineers' Shops are supplied with a large plant of the latest types of tools in the way of Lathes, Planing, Milling and Screwing Machines, Electric Cranes, etc., etc., and capable of executing the largest class of work with despatch. The Shipwrights' Department has attached to it a Steam-Sawmill with Circular, Vertical and Band Saws, and also a complete plant of Wood-working Machinery of the most modern and improved type. The Blacksmiths' Shops are equally well furnished with a complete supply of powerful Steam Hammers, Cranes, etc., capable of forging stern posts and crank and straight shafting of the largest size.

Powerful Lifting Shears with steam purchase at two of their Establishments stand on a solid granite seawall, alongside which vessels can lie drawing 24 feet of water, and take in or out boilers, etc. The Shears at Kowloon are capable of lifting 70 tons.

The Company is prepared to tender for the construction of new vessels in either steel, iron or wood, having already built about 400 of varying sizes up to 3,000 tons; also to execute all kinds of ship work at lower rates and with greater despatch than any establishment in the East. Every department is under the close supervision of experienced European foremen.

SHIP-YARD is fully equipped with modern plant, including hydraulic flanging and bending machines, electrically driven rolls, punching, shearing, angle-bevelling, joggling and planing machines, capable of dealing with the heaviest class of work.

BOILER-MAKERS' DEPARTMENT.—The Company, in addition to executing repairs, is prepared to tender for new boilers to steamships for the construction of which it possesses special facilities, including powerful punching and shearing machines, hydraulic rivetters, etc.

FOUNDRY.—The Foundry is fitted with a large powerful Steam Crane and the Cupolas are capable of casting up to 100 tons. The Company is prepared to supply the very best iron and Brass Castings of all descriptions upon the shortest notice.

GALVANIZING PLANT of the most modern type by electrical deposit has been put up at the Kowloon Establishment, which is capable of doing the largest class of work.

STORES.—The Company's Godowns contain large and well-selected stocks of all material and fittings requisite in shipbuilding, engine-room outfits, furnishings, and ships' stores of all descriptions supplied at tariff rates.

For Further Particulars apply at the Offices of the Company, Queen's Buildings, No. 1, New Praya, Hongkong, or to

FINDLAY & CO., Agents, Manila, P. I.

Cable Address:
"FARNHAM," SHANGHAI

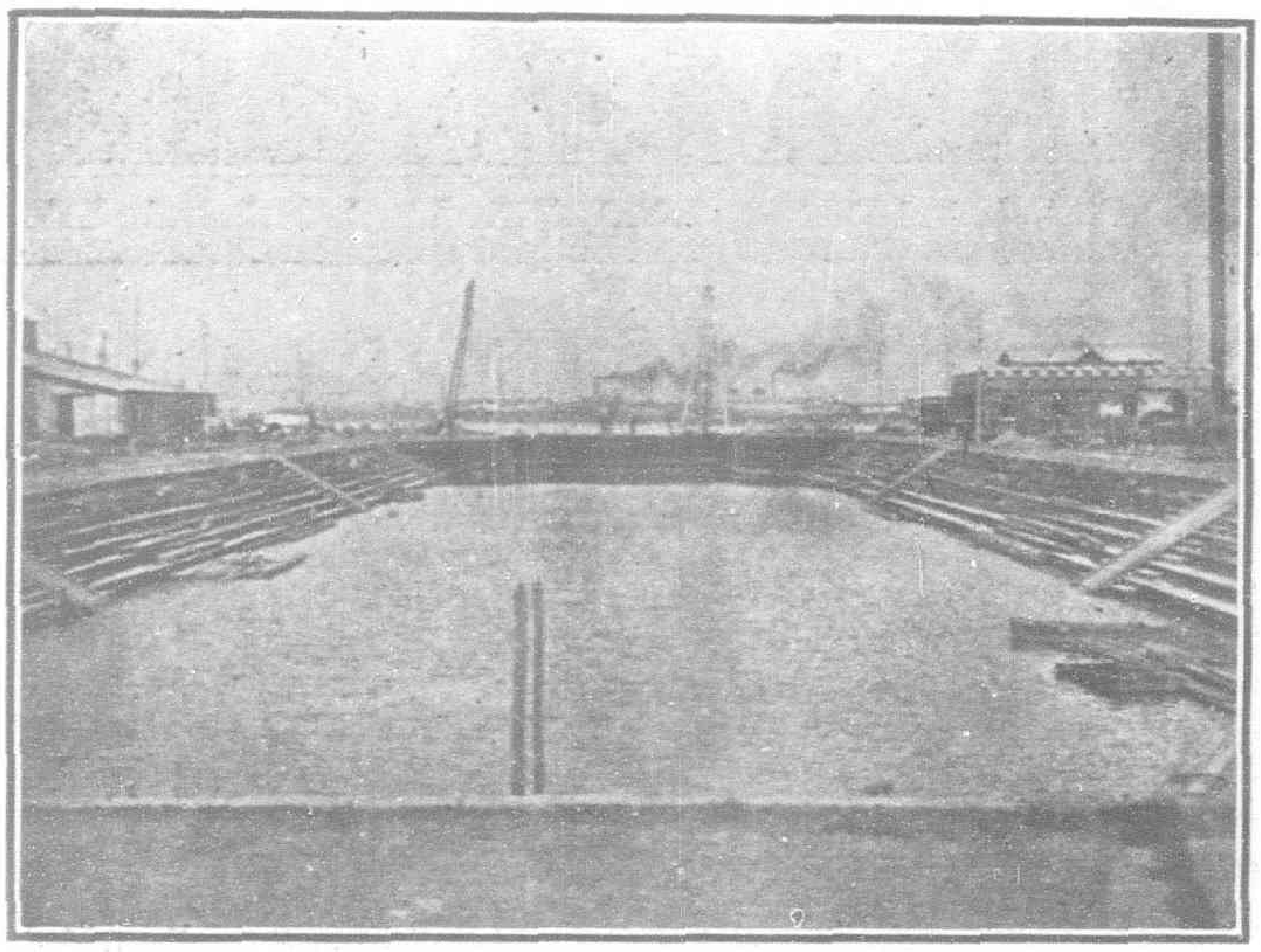
Codes Used:
A I., A B C (4th & 5th Editions)
Watkin's, Scott's, Western Union, and Engineering

THE SHANGHAI DOCK AND ENGINEERING CO., LTD.

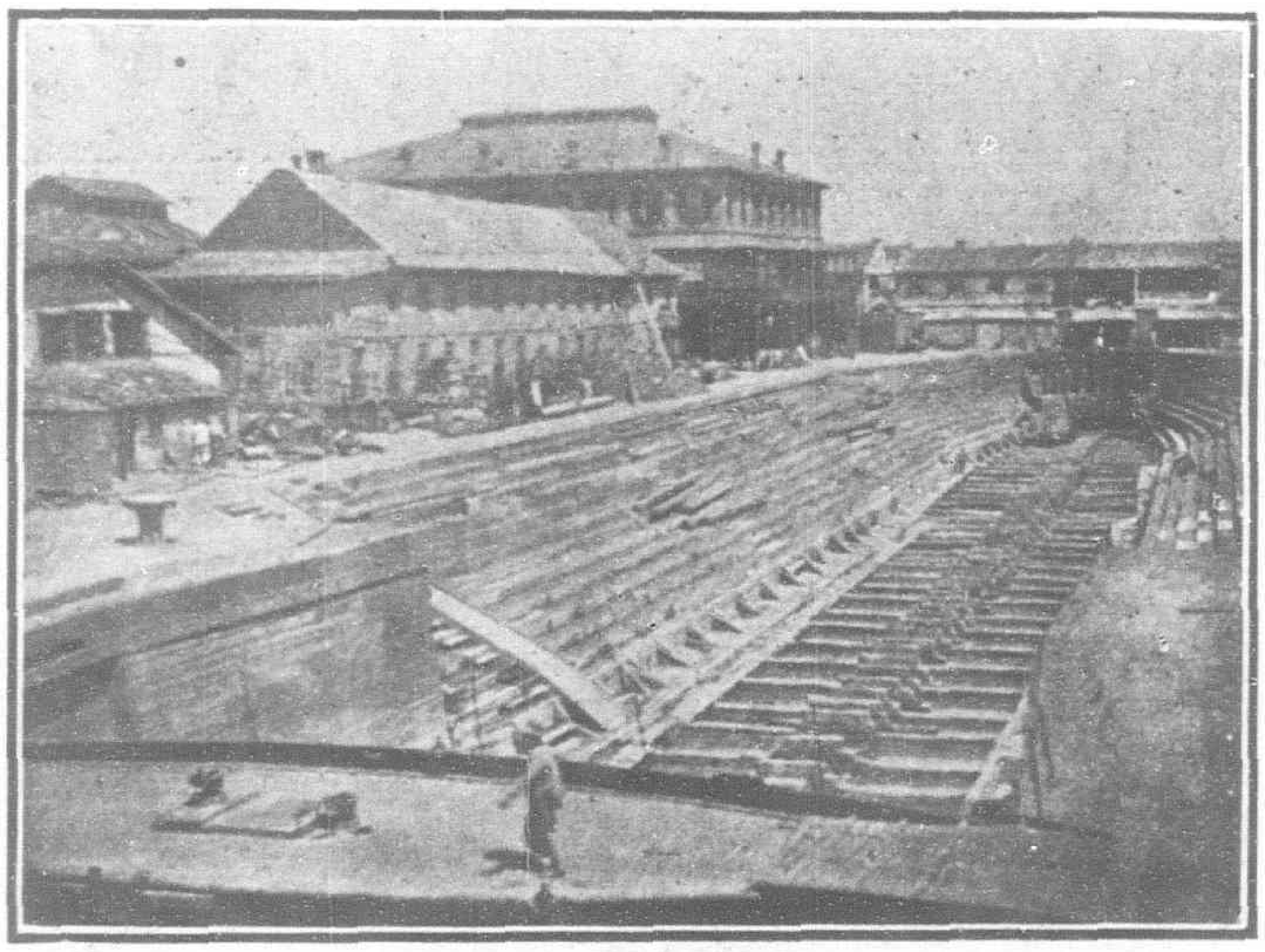
(Successors to S. C. Farnham, Boyd & Co., Ltd.)

SHANGHAI, CHINA

Dock Owners, Engineers, Founders, Boiler-makers, Shipbuilders, and Electricians



COSMOPOLITAN DOCK AT POOTUNG



OLD DOCK AT HONGKEW

THE DOCKS

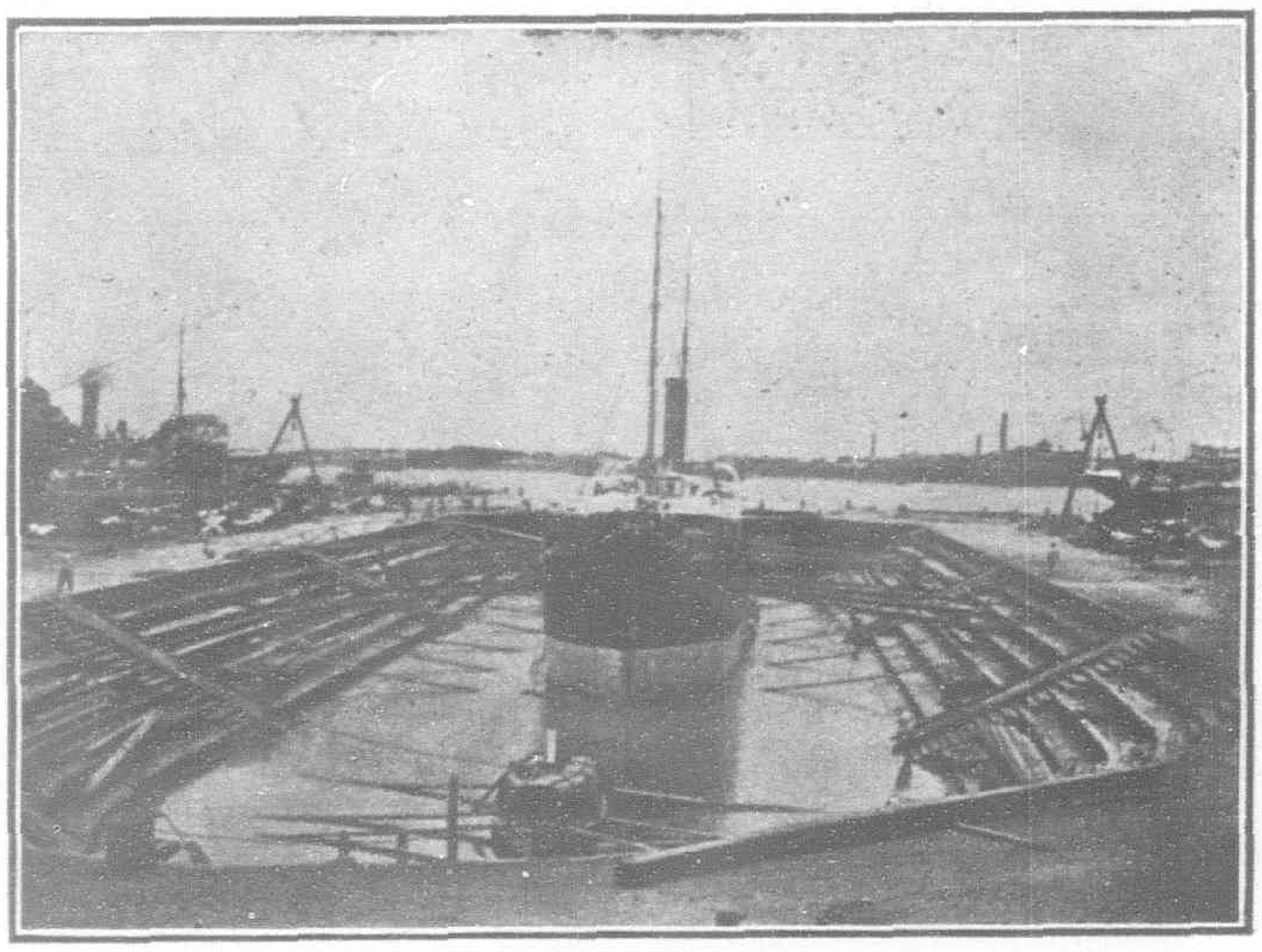
The Docks are five in number ranging in length from 360 feet to 560 feet, and breadth of entrance from 57 feet to 83 feet, with the depth of water on the sill from 16 feet to 24 feet.

The Dock charges are very moderate.

The Water Frontage is about 1½ miles in length. Wharves and Pontoons are arranged where steamers can moor during repairs; and slips for hauling up small vessels are provided. Sheer legs capable of lifting 65 tons are placed at the various Docks.

The extensive shipbuilding yards and workshops are provided with the latest improvements in tools, traveling cranes of 70 tons' capacity, hydraulic and pneumatic machinery.

Lit up by electric light with railway lines through workshops and yards.



NEW DOCK AT POOTUNG

OTHER WORKS

Powerful salvage appliances can be supplied at short notice. Enquiries immediately attended to.

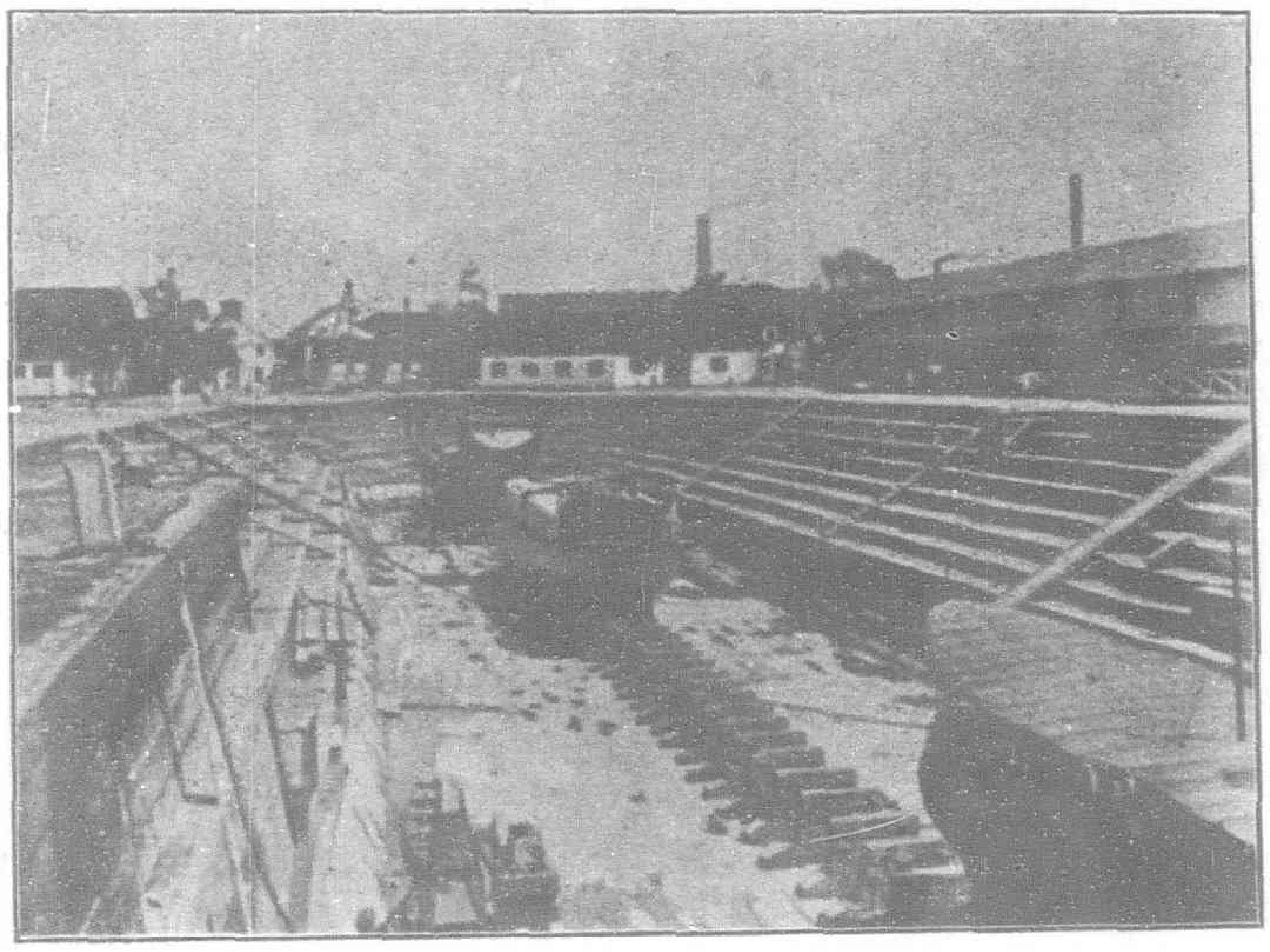
Estimates given for all classes of work; Coast Steamers, Side and Stern-Wheelers, Tugboats, Launches, Steam Barges, Dredgers, Floating Cranes, and Lighters a speciality.

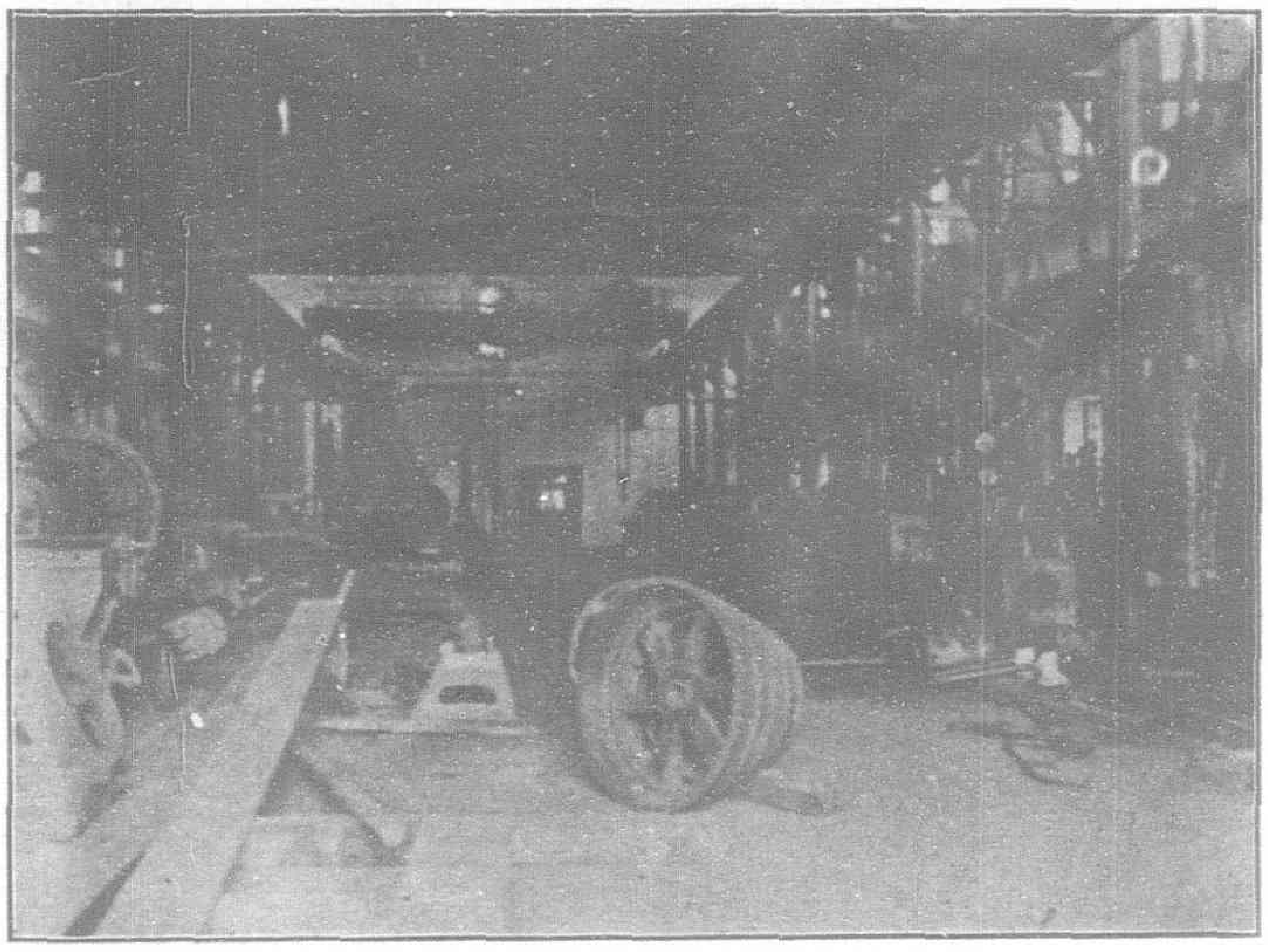
Every description of repairs and renewal work undertaken and expeditiously executed.

Land and Marine Engines and Boilers, Centrifugal, Mining, and other pumping machinery always in stock or in progress, also power-driven Machine Tools, Engineer's Hand Tools, Steam, Gas, Oil, and Electric machinery and engineering accessories generally.

CORRESPONDENCE INVITED

KIANGNAN
DOCK AND ENGINEERING WORKS





KIANGNAN DOCK—Length over all, 385′; length on blocks, 375′; water on sill, 19′; dock entrance, top, 70′, bottom, 60′.

The dock accommodates the largest coasting steamers and is equipped with complete modern facilities for handling work thoroughly and promptly.

The new machine and boiler shops, and the foundry and shipbuilding plant are equal any this side of Suez.

Patent slipway for small steamers and launches. Complete boat and launch building shops.

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ALL WORK GUARANTEED TO BE OF THE HIGHEST ORDER AND TO CONTAIN ALL THE MOST UP-TO-DATE IMPROVEMENTS

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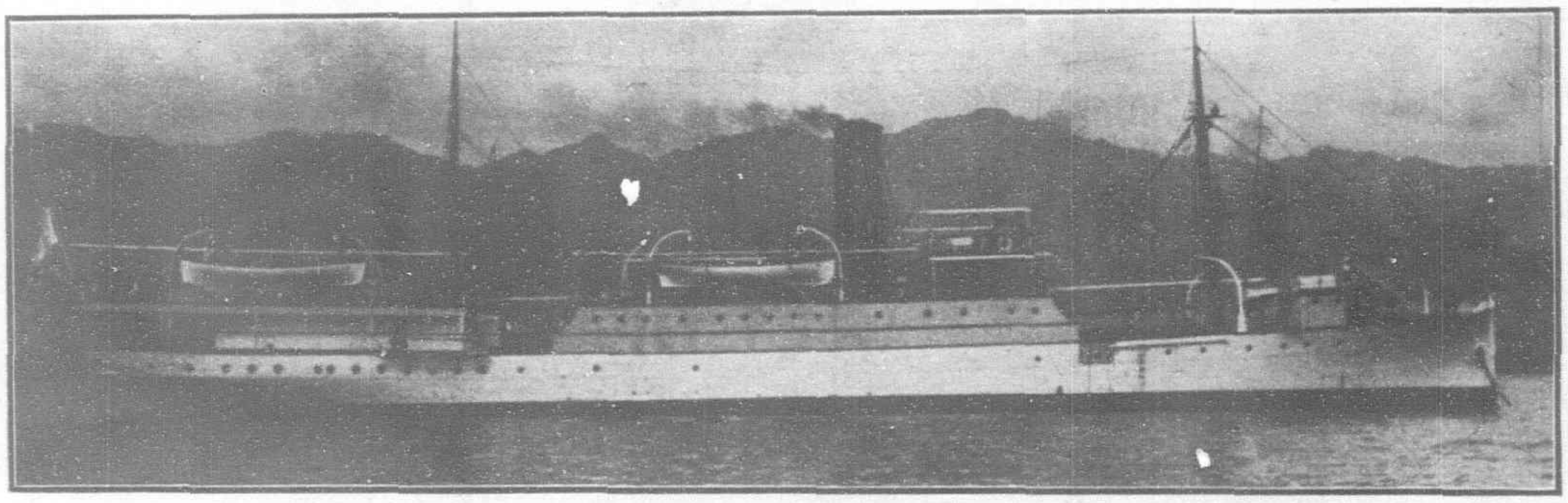
No. 1 GRAVING DOCK,
Length. . 425 ft. 6 in.
Width of entrance on top. . 63 ft. 6 in.
Width of entrance on bottom. 51 ft. 7 in.
Depth over sill. . 23 ft. 7 in.

No. 2 PATENT SLIP,
Length. . 180 ft. 0 in.



LIGHTHOUSE TENDER "KWANGCHEI," BUILT FOR THE IMPERIAL COREAN MARITIME CUSTOMS, 1904, BY THE KAWASAKI DOCKYARD CO., LTD.

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Y. Kawasaki, *Vice-President*
M. Yotsumoto, *Secretary*
H. Kumata, *Accountant*
F. T. Sumura, *Superintendent*
T. Saka, Dr., *Chief Engineer*
T. Tanaka, *Chief Constructor*
G. Matsukata, *Chief Storekeeper*

The Dockyard extends along almost the whole length of the shore of the Western Harbor and is in close proximity to Shipping Berths.

Cable Address
R. REYES
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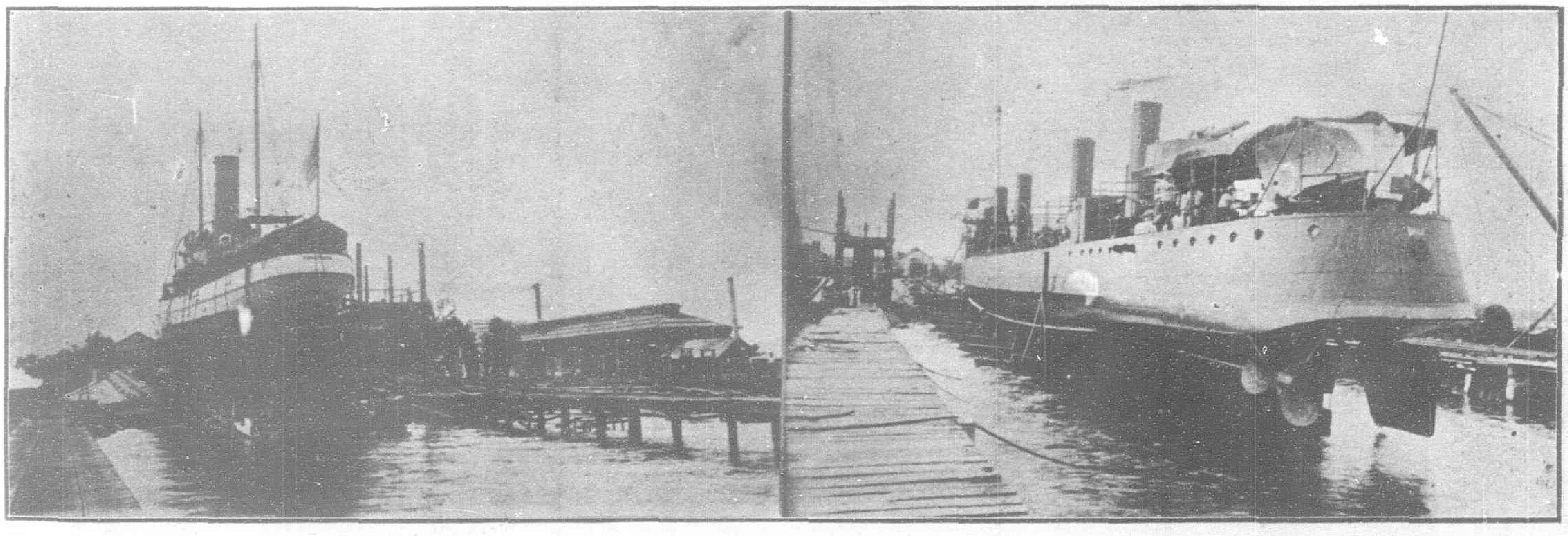

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Our Slipway is equipped with an up-to-date plant, and carries a large stock of material for the repair of ships, engines and boilers.

SHIPYARDS and DOCKS located at the sheltered harbor of Canacao, Cavite, P. I.

SLIP No. 1. Length 320 feet capacity 2400 gross tons
SLIP No. 2. " 210 feet capacity 1200 gross tons

RAFAEL REYES
General Manager

Director of Works,
MR. A. YOUNG

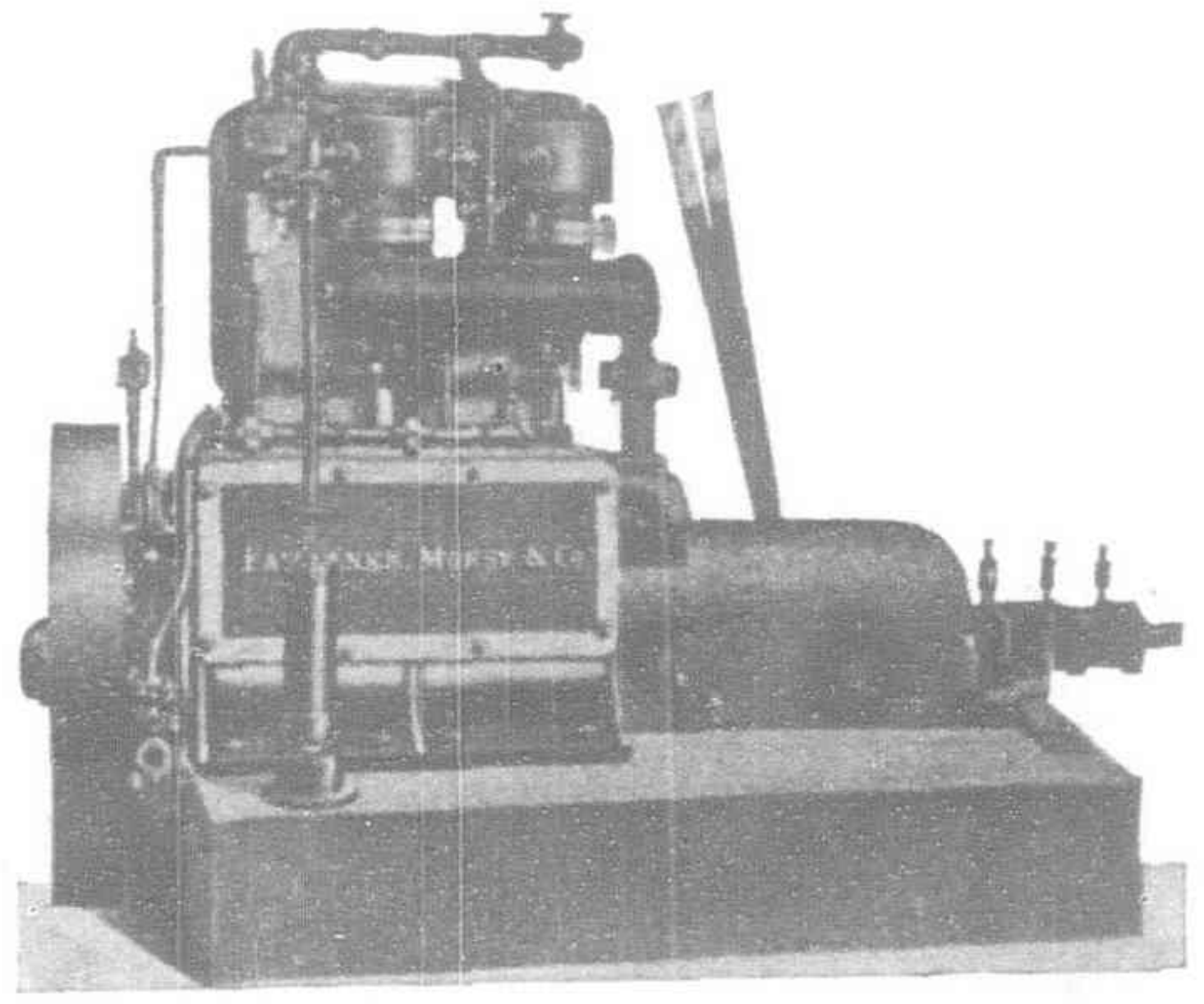
P. O. Box
202

THE MANILA SLIP COMPANY
MANILA, P. I.

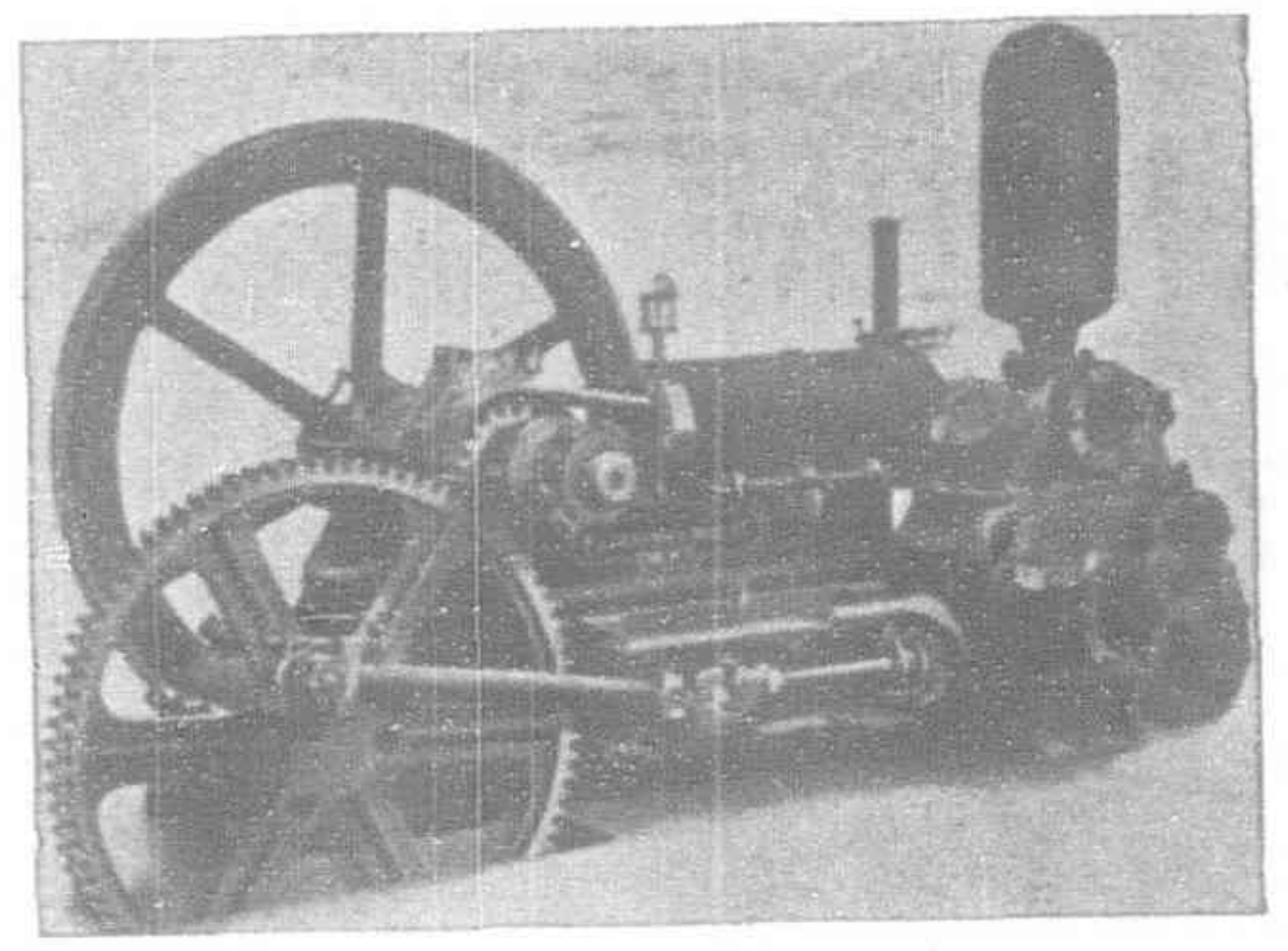
HEAD OFFICE
Manila, P. I.

CASTLE BROS.-WOLF & SONS.

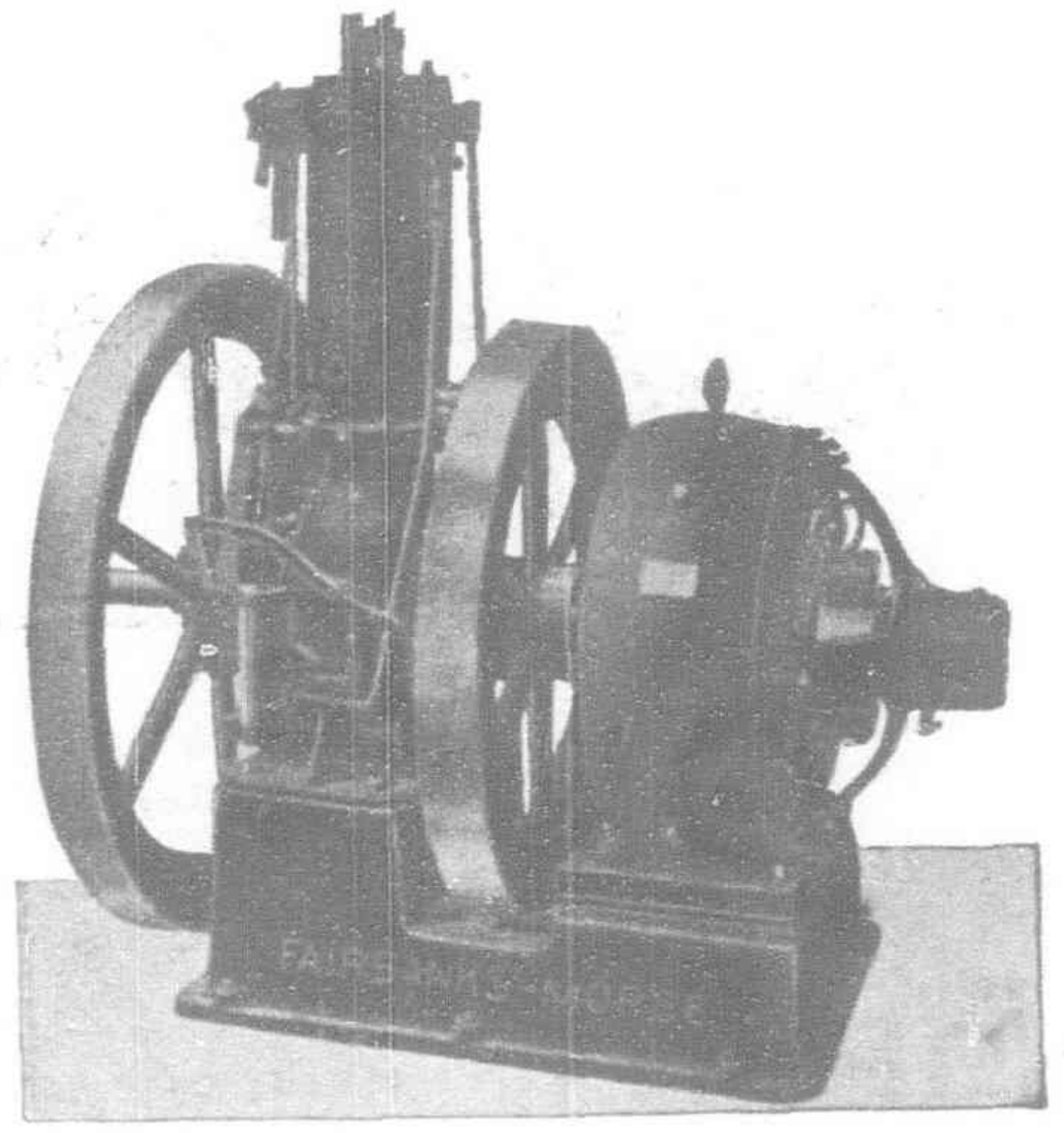
ENGINEERING DEPARTMENT



MARINE



GAS ENGINE AND PUMP



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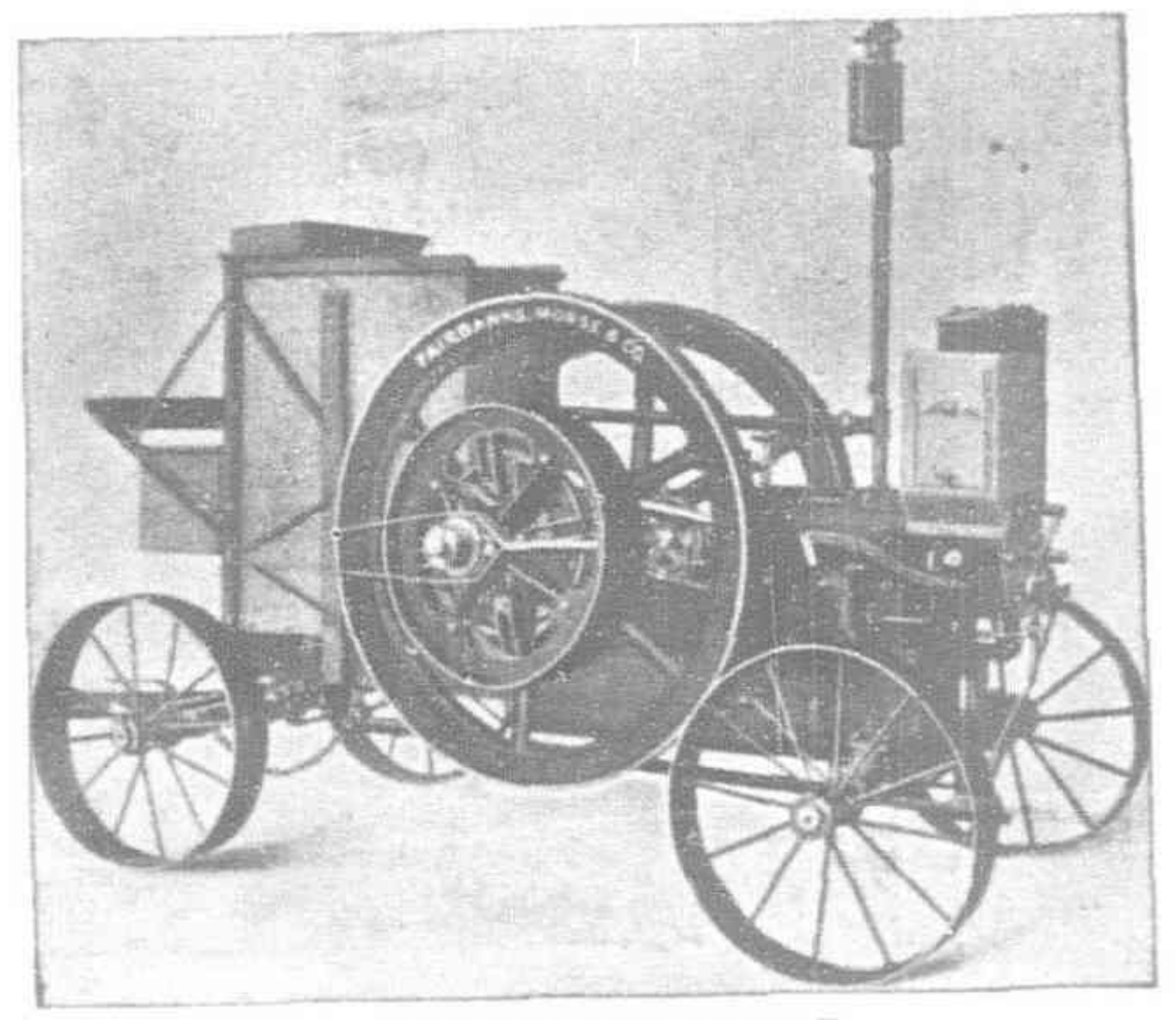
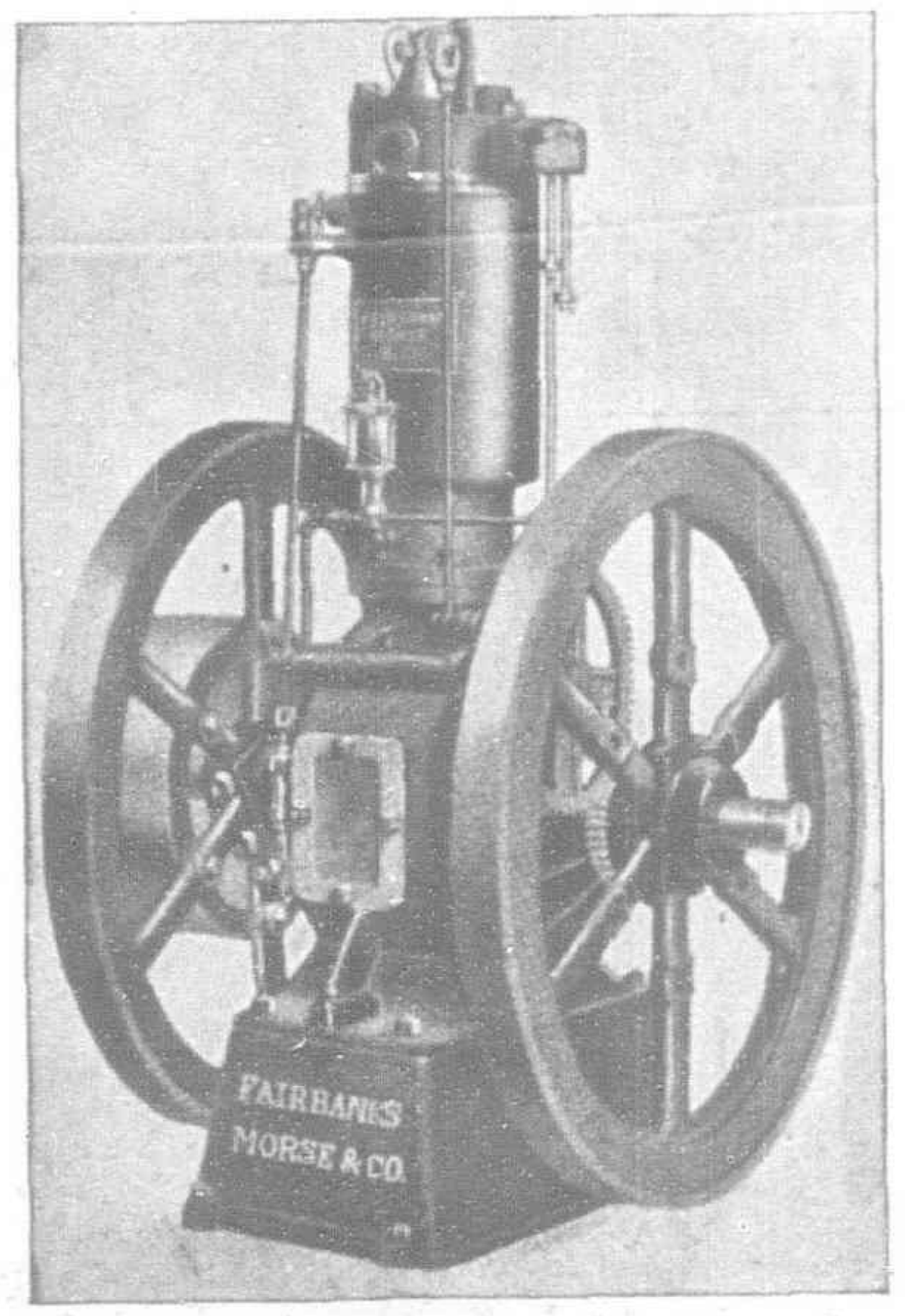
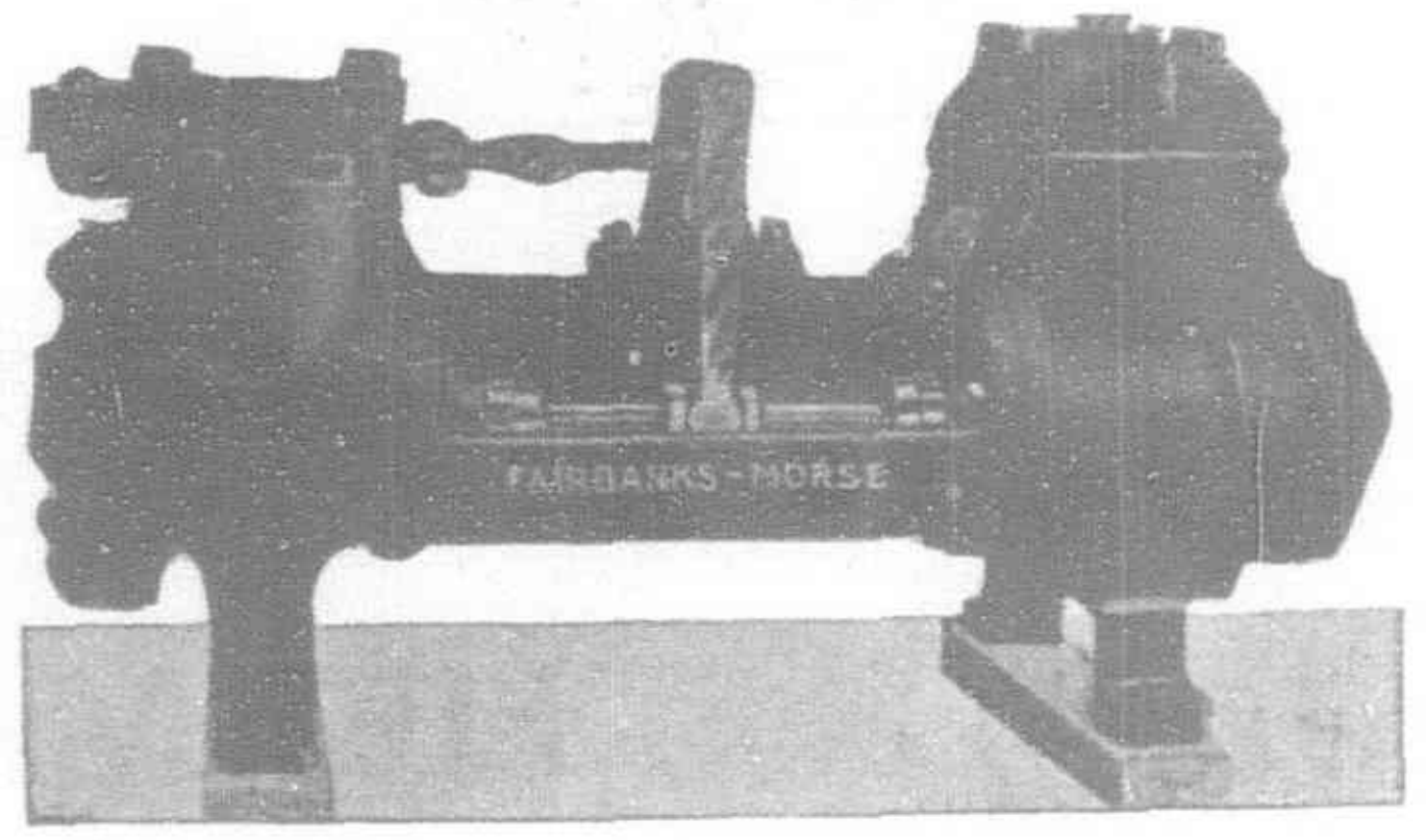


PORTABLE GAS ENGINE



VERTICAL ENGINE



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FORWARDS

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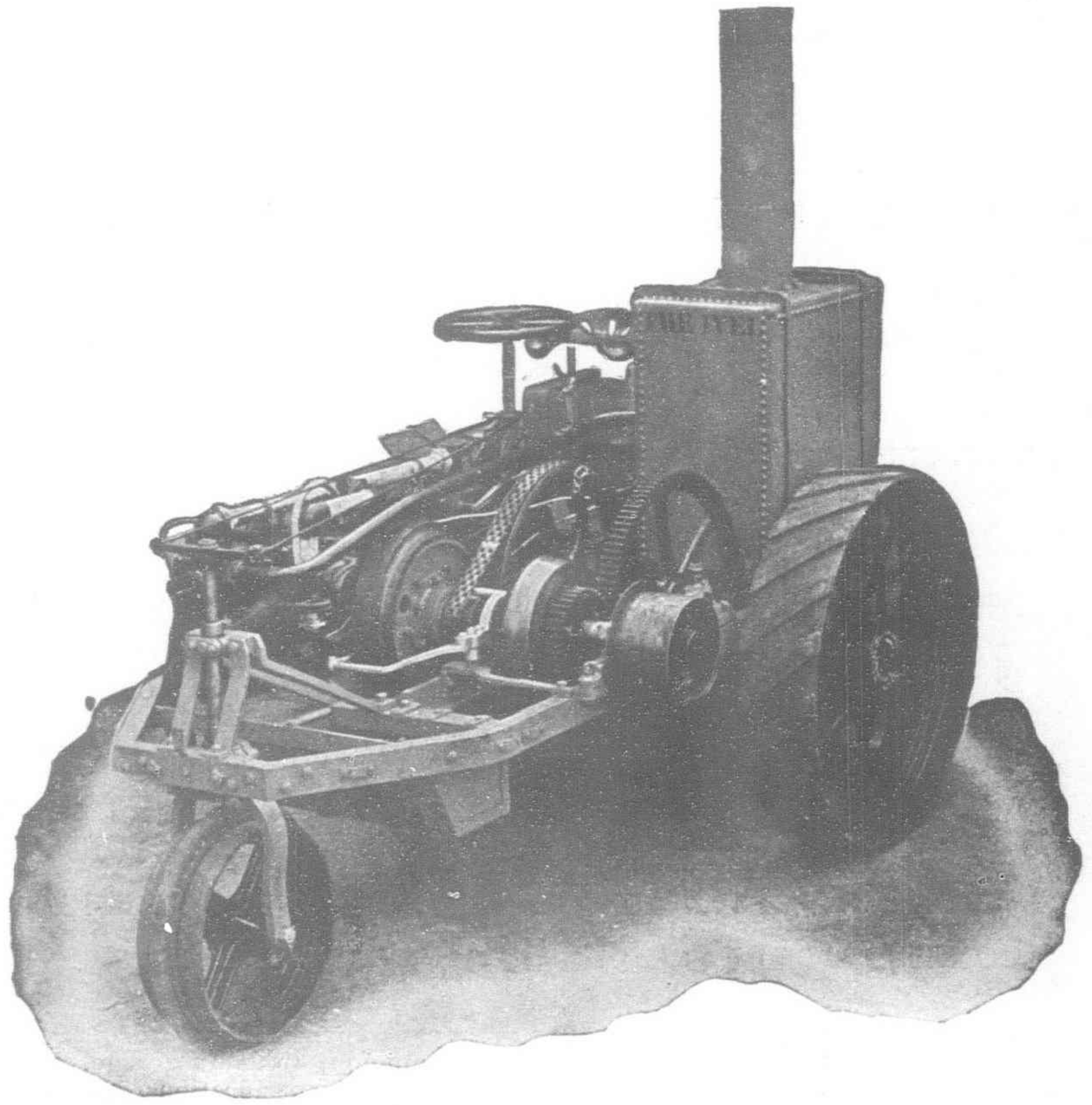
WOODEN BEAM PLOWS
IRON CRUSHING
PLOWS

STEAM PUMPS
HAND PUMPS

WIND MILLS
SUGAR MILLS, ETC.



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INVITATION TO MAKE TIES FROM THE TIMBERS OF THE PHILIPPINE ISLANDS FOR USE IN THE CONSTRUCTION OF THE PHILIPPINE RAILWAYS.

THE PHILIPPINE RAILWAY COMPANY will enter into contract with any party wishing to furnish ties five inches by eight inches by seven feet long, made from the following timbers: molave, ipil, yacal, betis, dungon, tindalo or acle, native of the Philippine Islands, as needed for use in the construction of its railways, in accordance with its standard specifications, at the prices and under the conditions following:

(a) When delivered by the contractor to the company and inspected by it in its material yards or on its rights-of-way, one peso and sixty centavos (₱1.60) for each specification tie.

(b) When delivered by the contractor to the company on board vessel or lighter after being duly inspected by it at some agreed upon accessible point on the coast line or at a harbor of any of the islands from where they can be safely put aboard for shipment, one peso and thirty centavos (₱1.30) for each specification tie.

The company under invitation (a) will accept any number of ties above ten.

Under invitation (b) any number exceeding one thousand.

The company will make contracts to take an agreed number at these prices at any time during the year 1907, but will not accept any without a contract executed with the party offering.

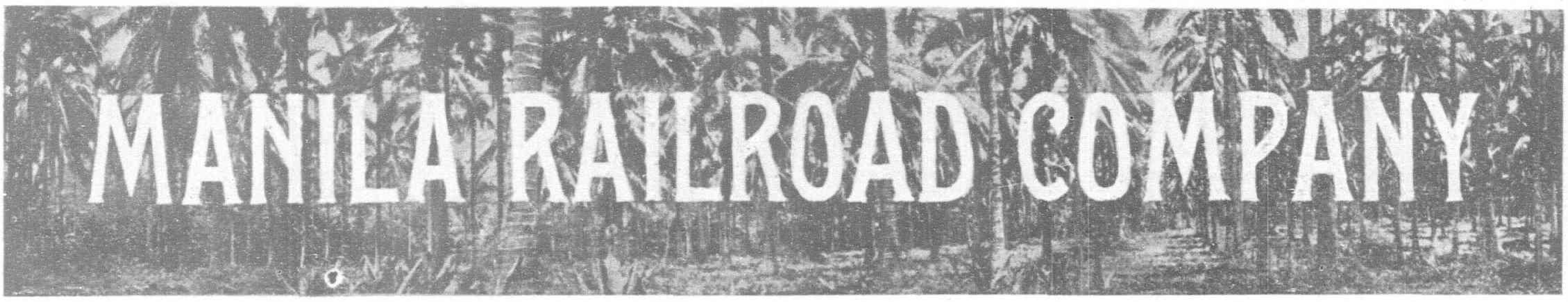
The company asks no penalty for failure of the contractor to furnish the number he agrees to furnish, giving each contractor the opportunity to cancel his contract at any time he finds the price unprofitable. The principal object of the contract, outside of the requirement of compliance with the specifications, is to keep the chief engineer informed as to who is making the ties and the quantity the contractor is likely to be able to supply.

THE PHILIPPINE RAILWAY COMPANY is, under Act No. 1497, exempt from the payment of any tax on timbers cut from Philippine Public Lands required by it in the construction of its railways; hence, the maker is exempt from timber tax when cutting timber for railroad purposes under licences, issued by the Bureau of Forestry. Before any ties will be accepted the contractor or maker must show that the ties are free from debt.

For further information, copy of contract and specifications, address or call on any of the following:
Theobald Diehl, Purchasing Agent, Manila, P. I.;
J. M. Robinson, Engineer, Iloilo, Panay, P. I.;
C. H. Farnham, Engineer, Silay, Negros Occ., P. I.;
H. F. Howe, Engineer, Cebu, Cebu, P. I.

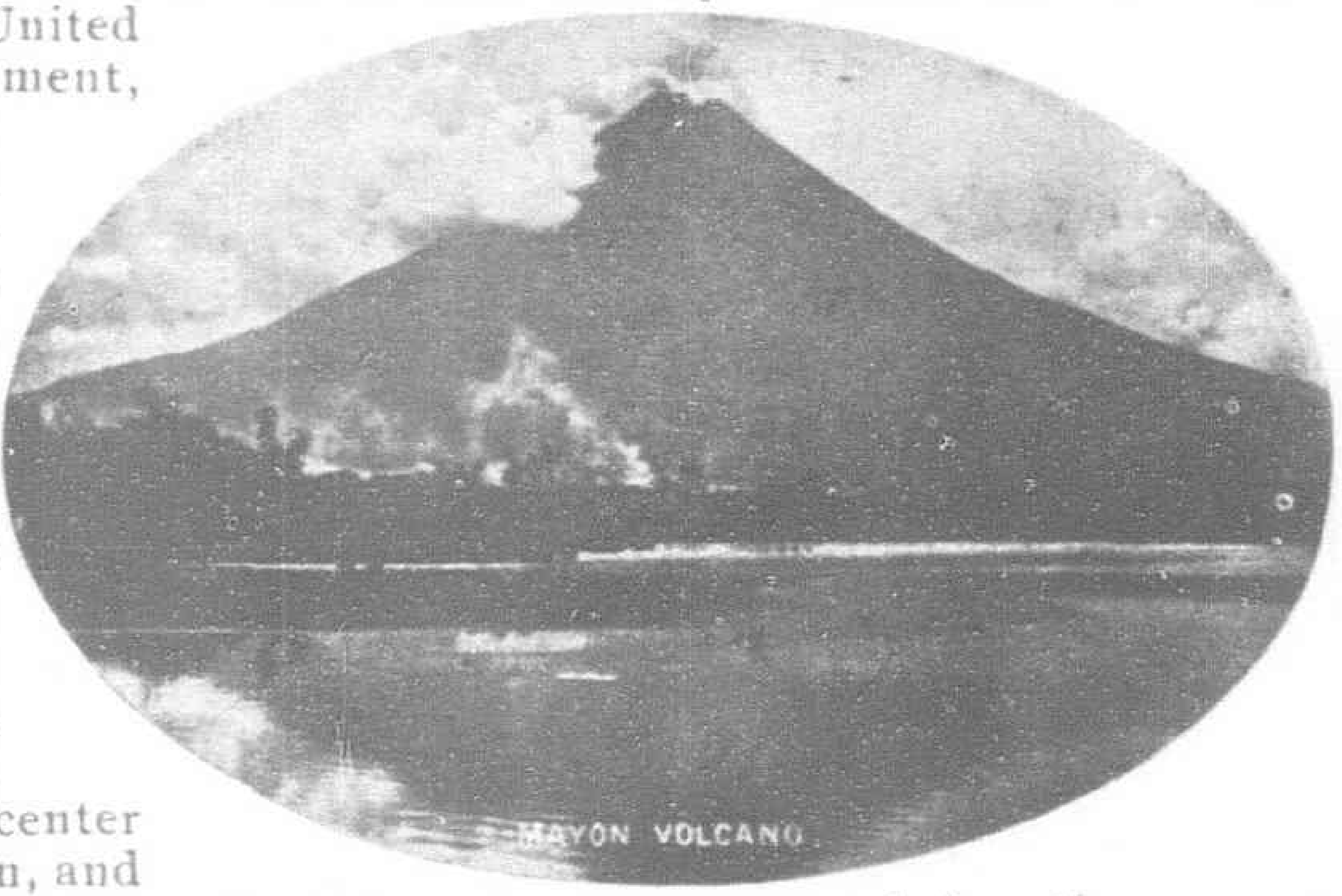
October 1, 1906.

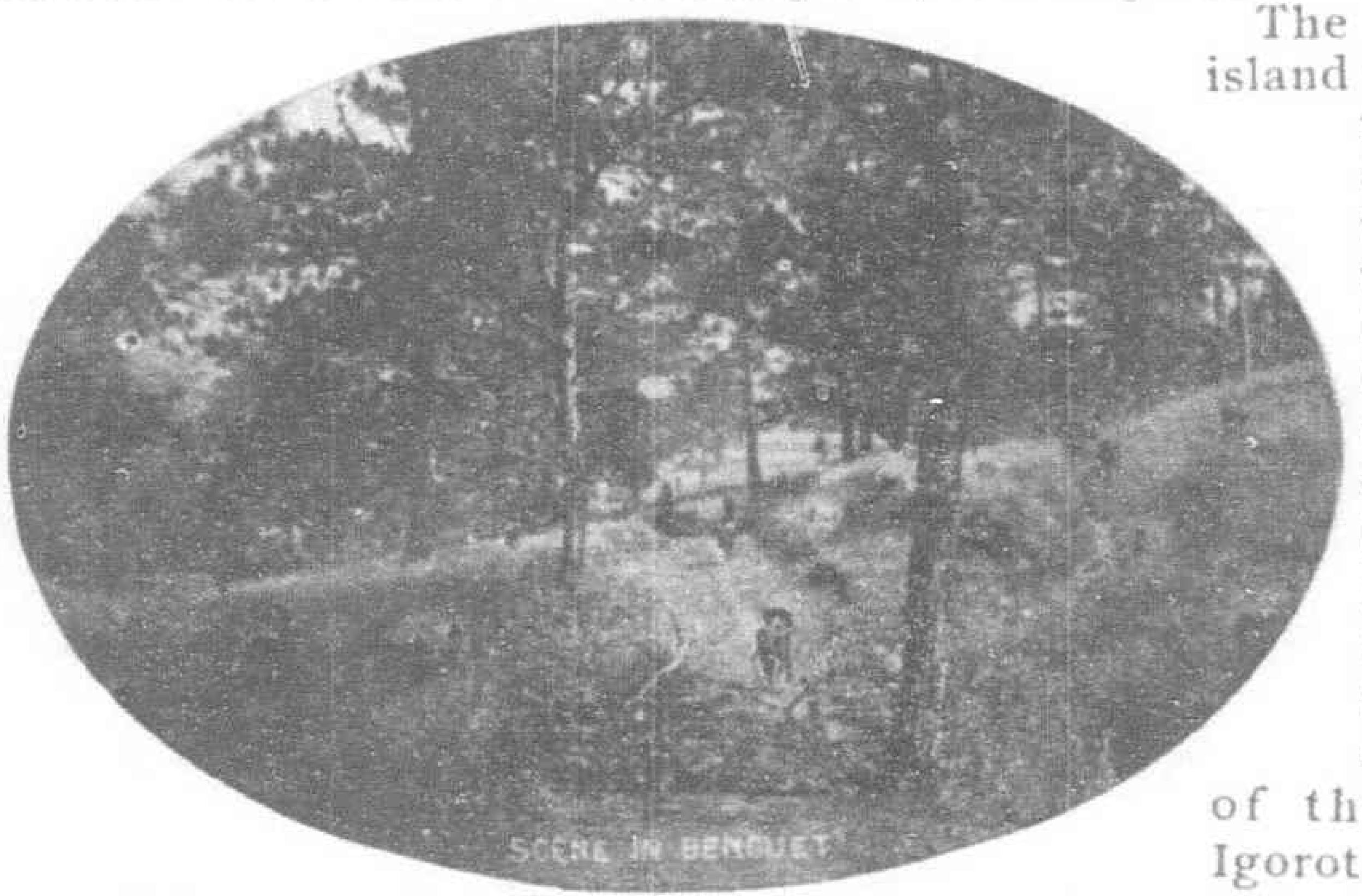
E. I. BEARD. *Chief Engineer.*



MANILA RAILROAD COMPANY

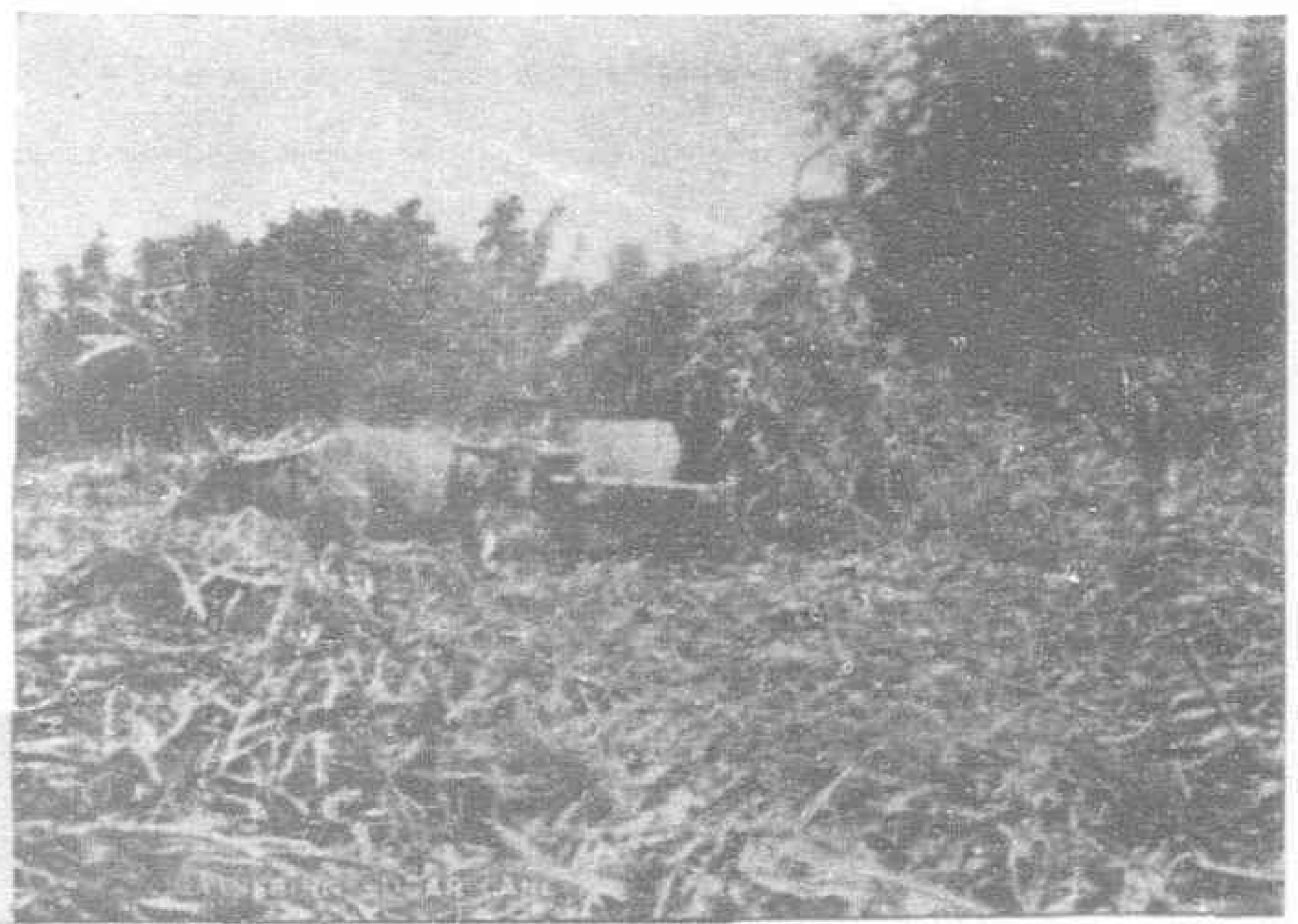
The **MANILA RAILROAD COMPANY** now has under construction in the Island of Luzon, the largest and richest of the Philippine Archipelago, a system of railroads under franchises obtained *from the Government of the* Philippine Islands, with the consent and approval of the United States Government, which will open for settlement and development thousands of square miles of splendid agricultural and mineral lands.


MAYON VOLCANO.


SCENE IN BENGUET

These lines will have an aggregate length of about 600 miles, with Manila as the center of their radiation, and they will not only tap all the best deep-water harbors in Northern and Southern Luzon, but with their main lines and branch roads will pass through country that for fertility and productive qualities is a veritable farmer's paradise. They will also reach the centers of the densest population where flourishing local markets are capable of handling the largest crops.

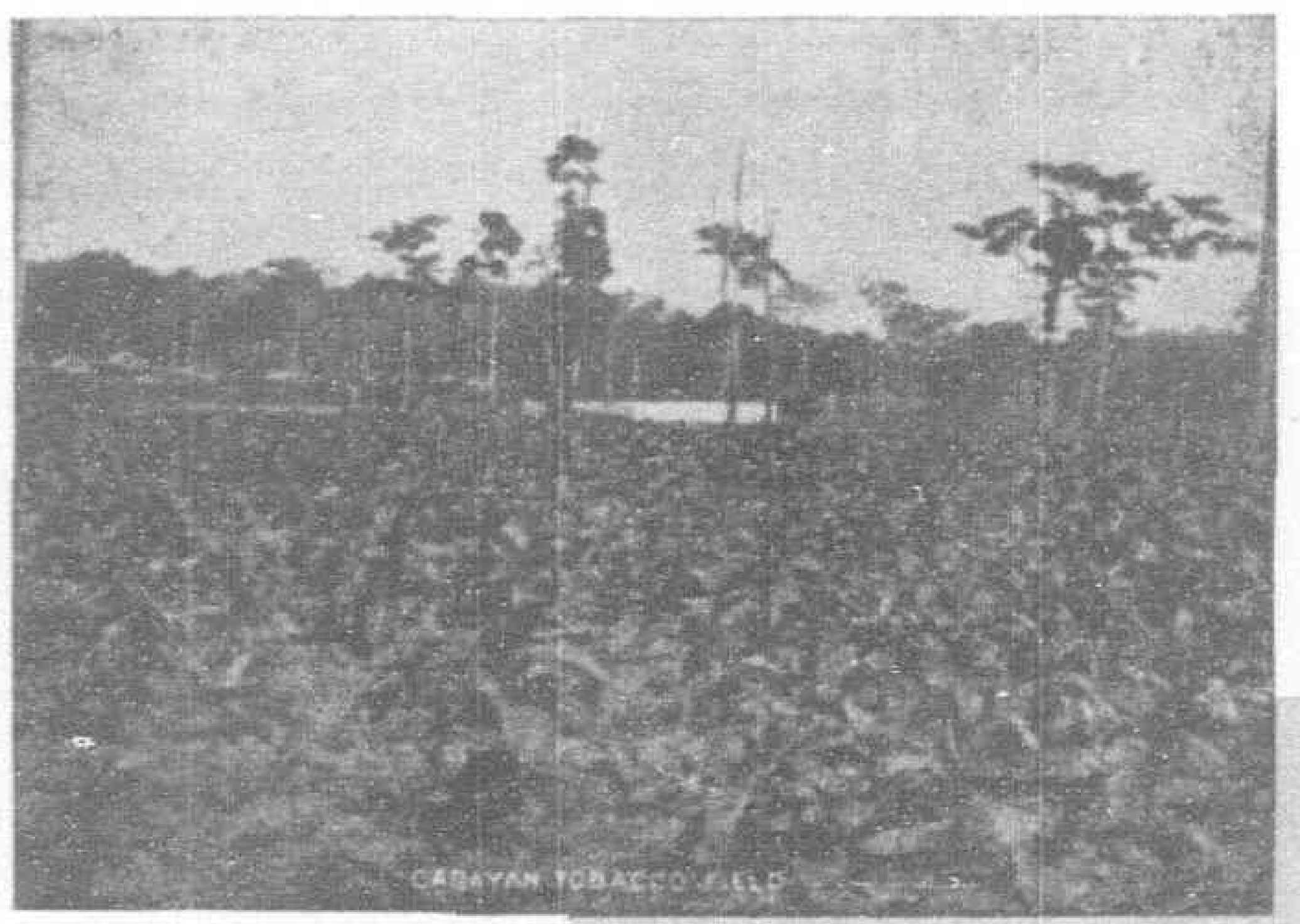
Eventually the gold regions of Benguet and Bulacan, the copper regions of Lepanto-Bontoc and Mancayan-Suyoc, and the iron regions of Angat, together with cement beds in Northwest Luzon, and the coal fields of Polillo, off the east coast of the Island, will be tapped by these steel highways.



RICE HARVEST

The tobacco-growing valley of the Cagayan will be in direct communication with Manila, and everywhere along the lines of the Northern System and in the numerous mountains through which the roads will pass or skirt, is rich rice and coffee land awaiting the introduction of modern methods of cultivation to bring them up to the highest grade of production.

Richer still is the country in Southern Luzon that these lines will tap. Here tropical products are to be grown in all their luxuriant varieties.


CAGAYAN TOBACCO FIELD

In the Laguna country is rice, cocoanut and cacao land; in Tayabas Province cocoanuts and rice are the leading staples, while in Sorsogon, Albay and Ambos Camarines *abacá* or Manila hemp, cotton and other useful fibrous products, coffee, cacao, rice and cocoanuts abound. All of the cocoanut-growing districts are great copra centers, and in the Province of Albay is to be found the best hemp in the world growing in abundance.

The construction of the new railroads will be followed by the establishment of large plantation enterprises which must necessarily result in general prosperity. There will be plenty of room for limited capital everywhere, so the settler with a few thousand dollars will in his small way find opportunity for profitable investment.

Luzon is the largest island in the Philippine Archipelago. It has 40,969 square miles and is almost entirely inhabited by civilized and Christian tribes who are peaceable and law-abiding. It abounds in forests of the most useful and beautiful hardwood groups, numerous and in many instances swift and powerful rivers and waterfalls, so that with the introduction of railroads lumbering must necessarily have an impetus.

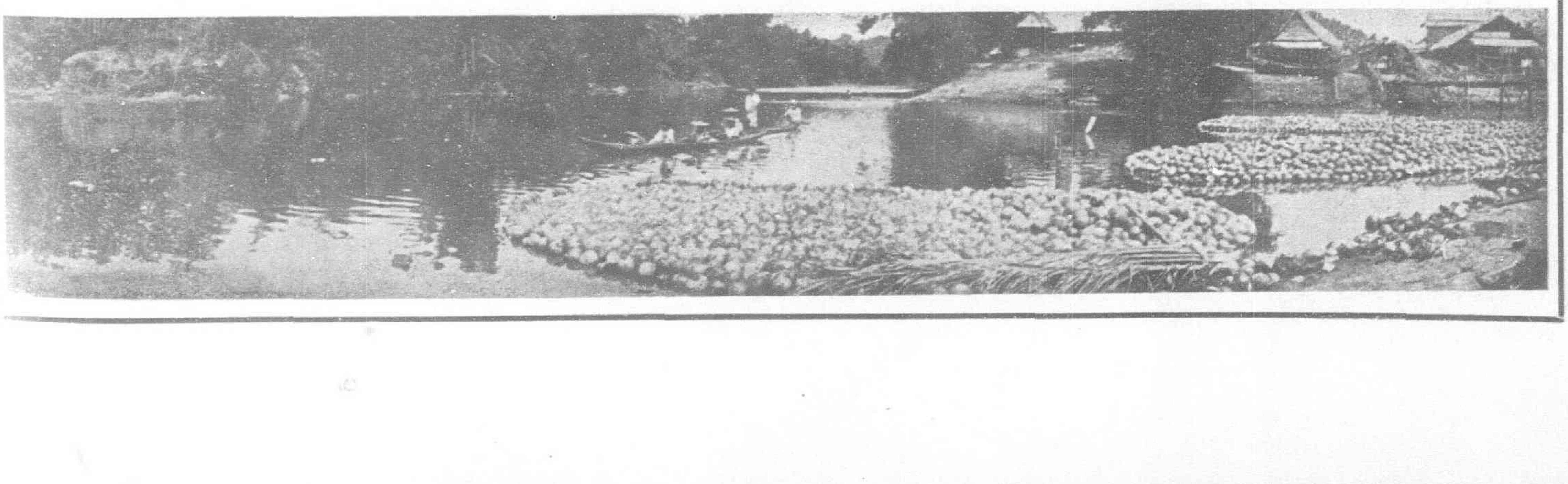
The climate of the island is sublime, particularly in the northern section, where, in the Province of Benguet, the Insular Government has established at Baguio its summer capital. Baguio is a famous resort in the heart of the interesting Igorot country, and everywhere around picturesque and majestic scenery abounds to attract the eye.

In Southern Luzon the lines will skirt the base of several historic volcanoes, notably among the active ones being Taal in Batangas Province, the most famous of all Philippine craters, and Mayon in Albay Province, reputed by scientists to be the most perfectly-shaped conical mount in the world.

PHILIPPINE CARABAO

All lines of the **MANILA RAILROAD COMPANY** will be equipped with the best and most modern rolling stock that can be purchased in the leading manufacturers' markets of the world.

Surveys of all the extensions provided for in the concession are now well under way, and materials for the actual work of construction are arriving in large quantities.



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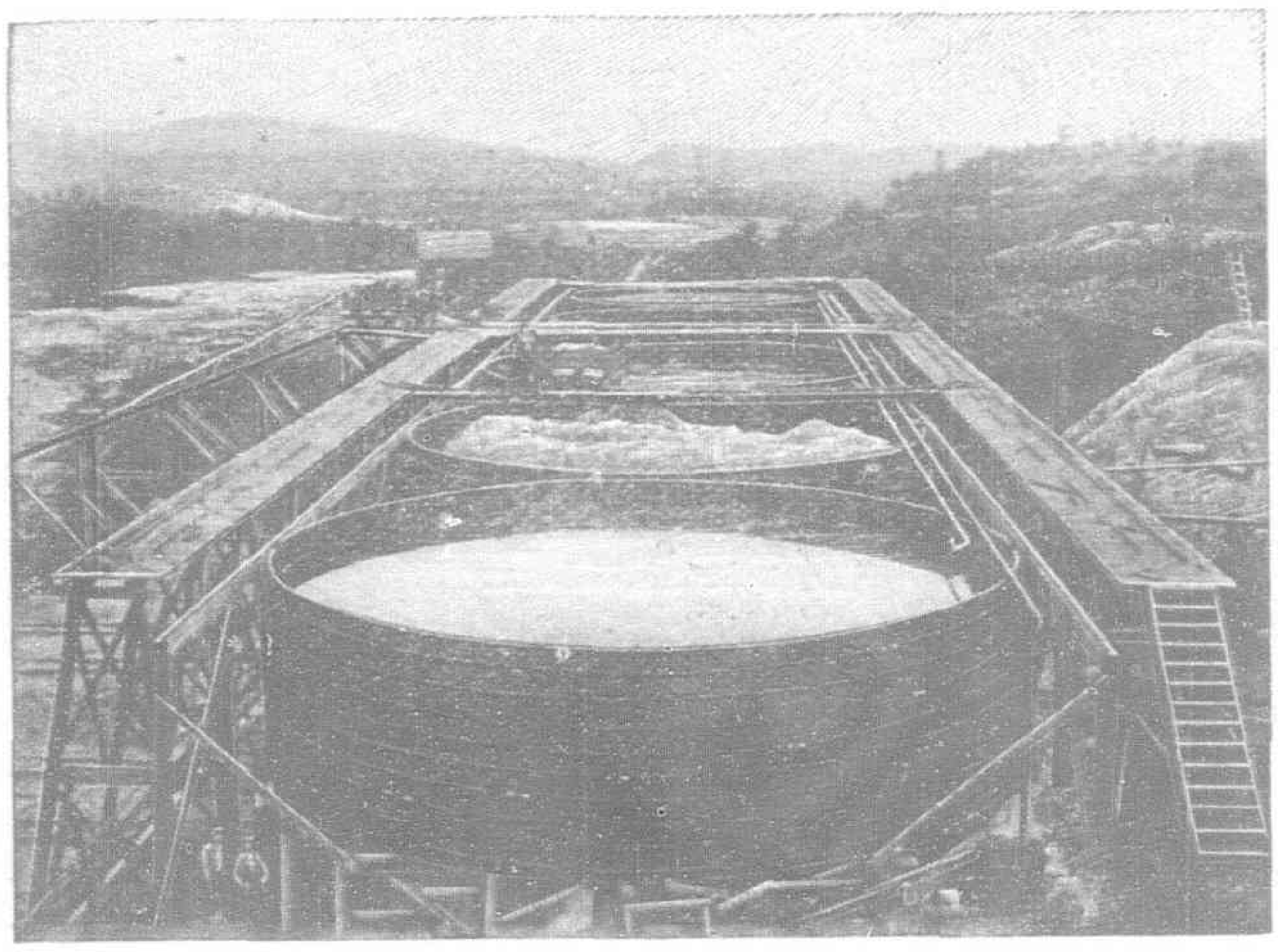

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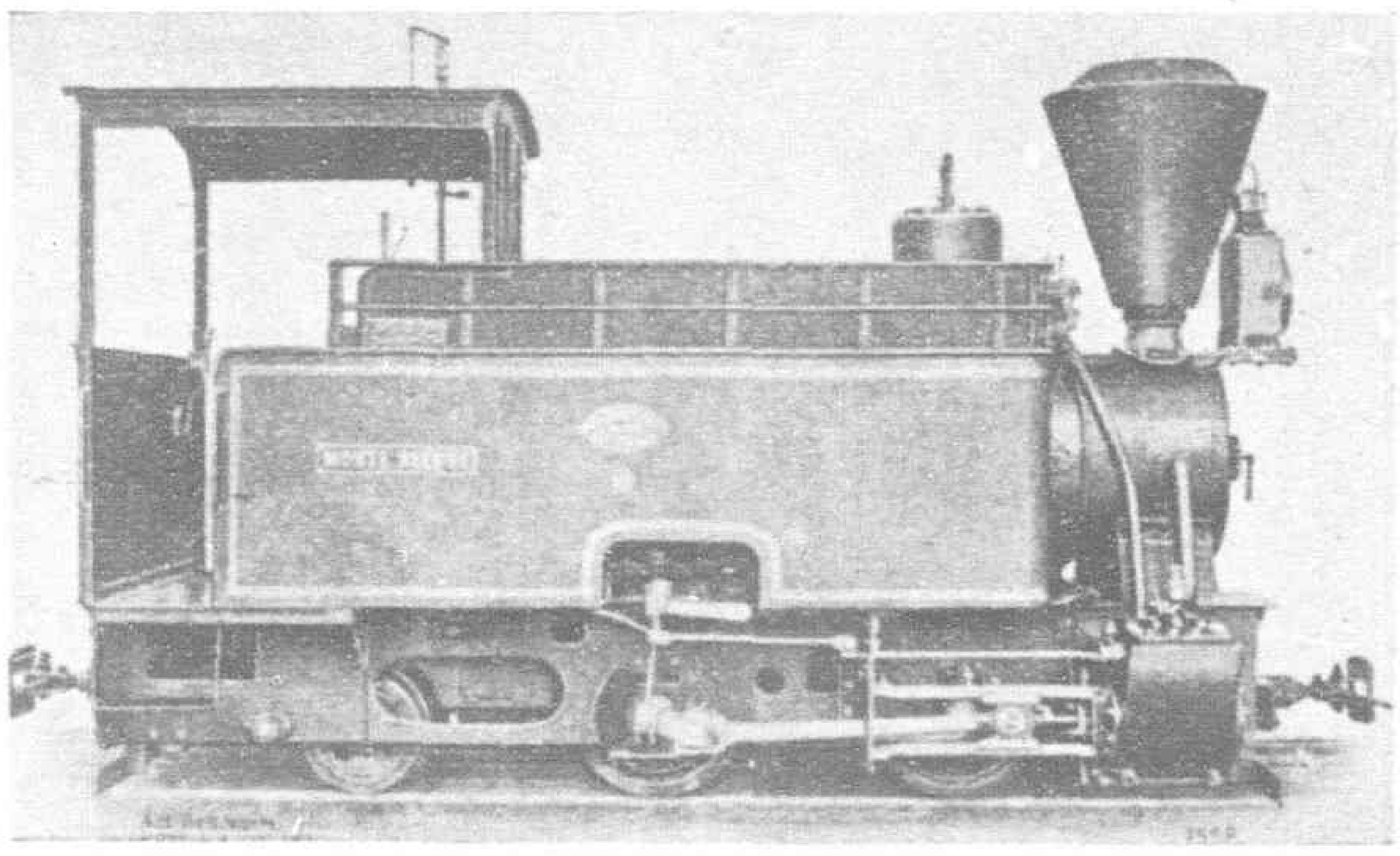
Special Locomotive Works

Yearly Output 400 Engines up to 60 tons Weight.



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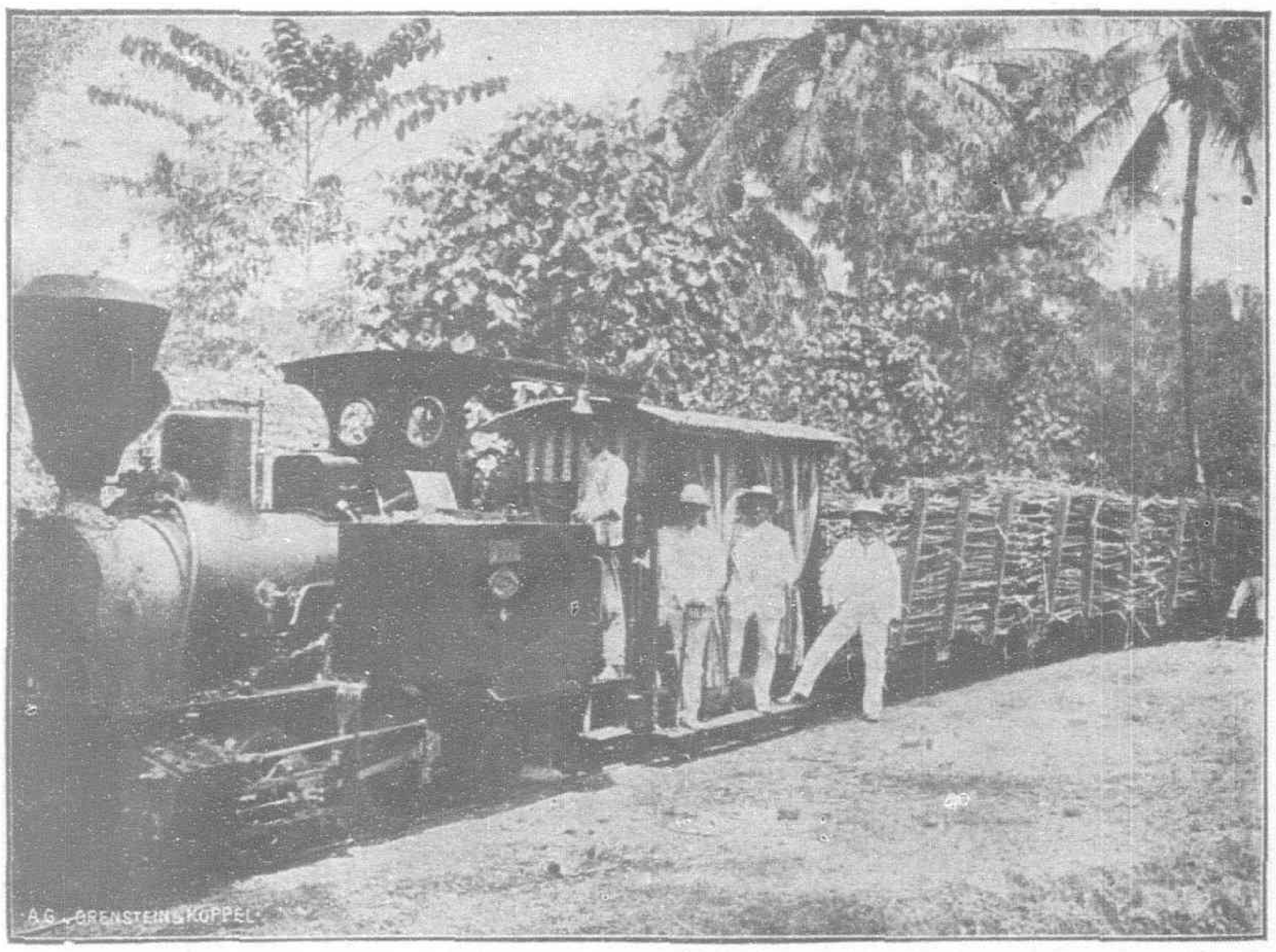

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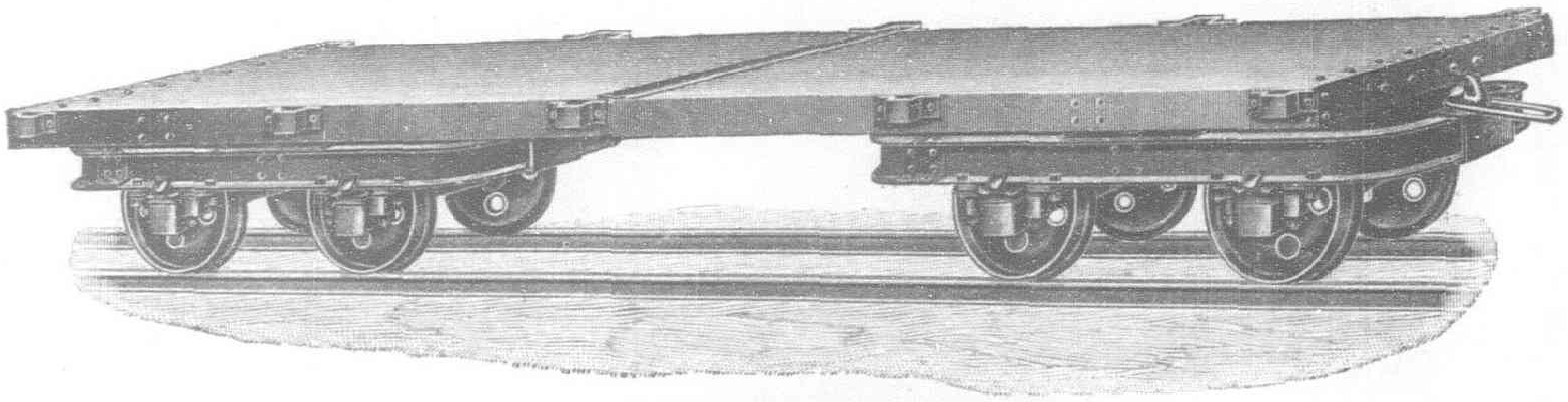

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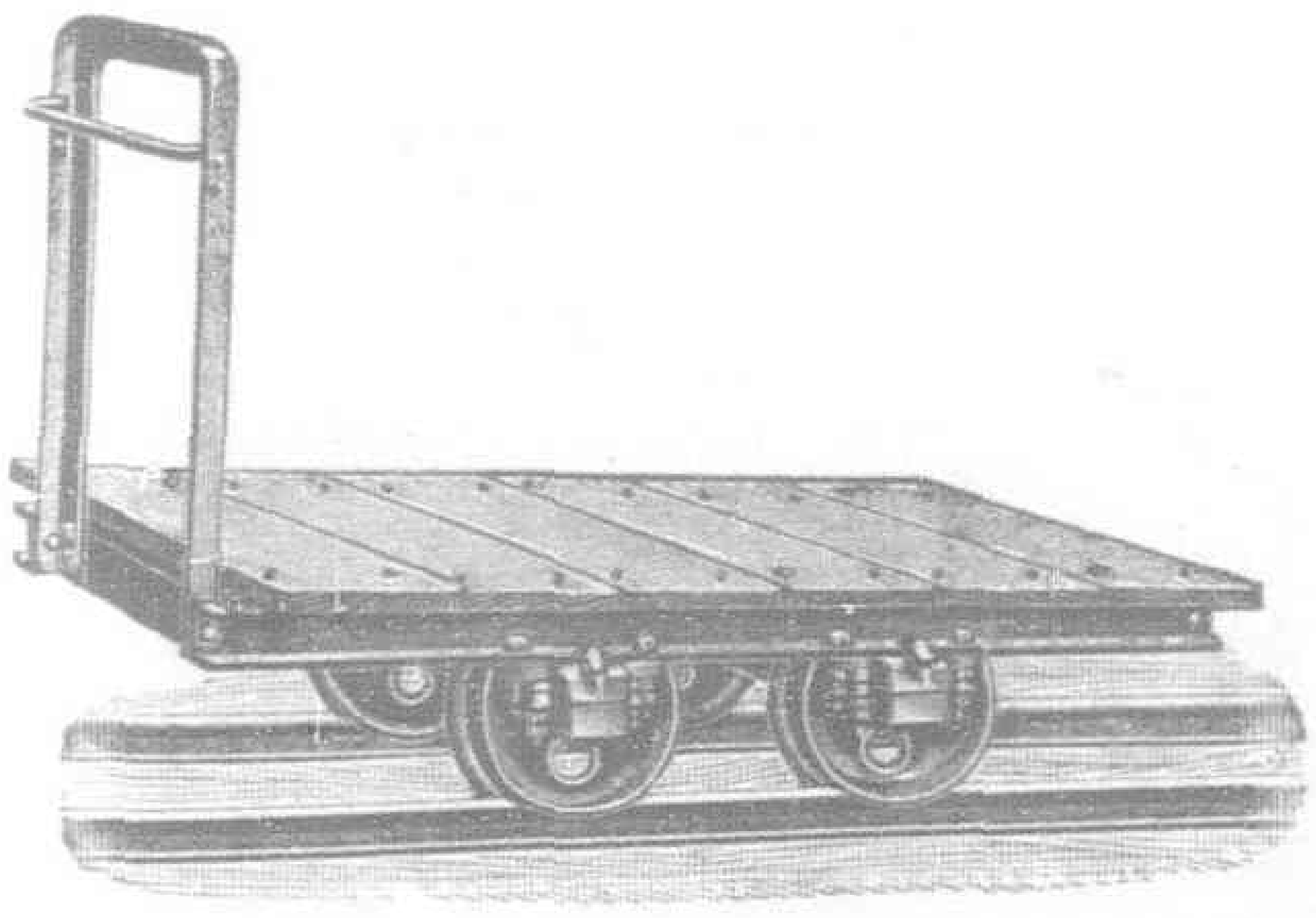

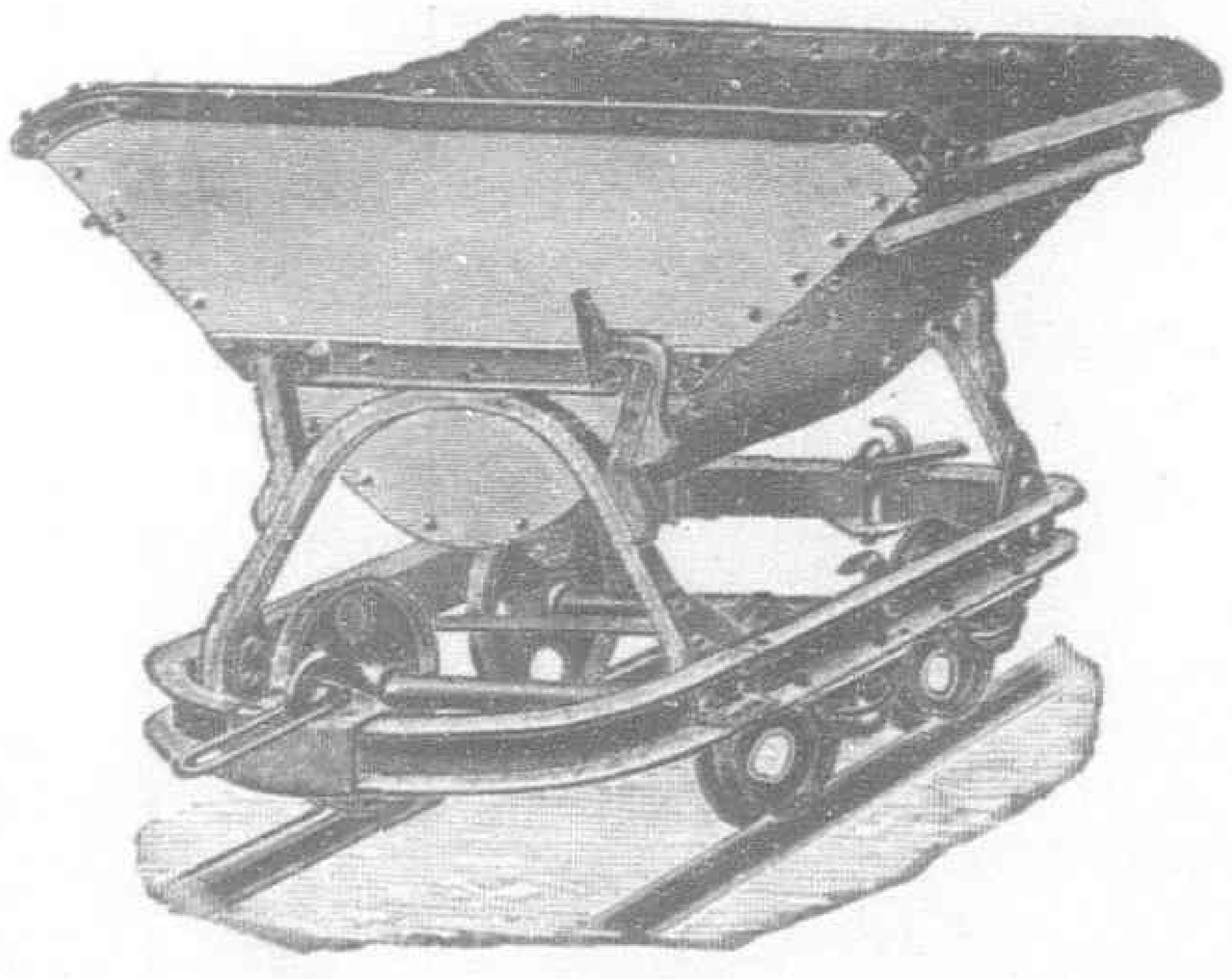

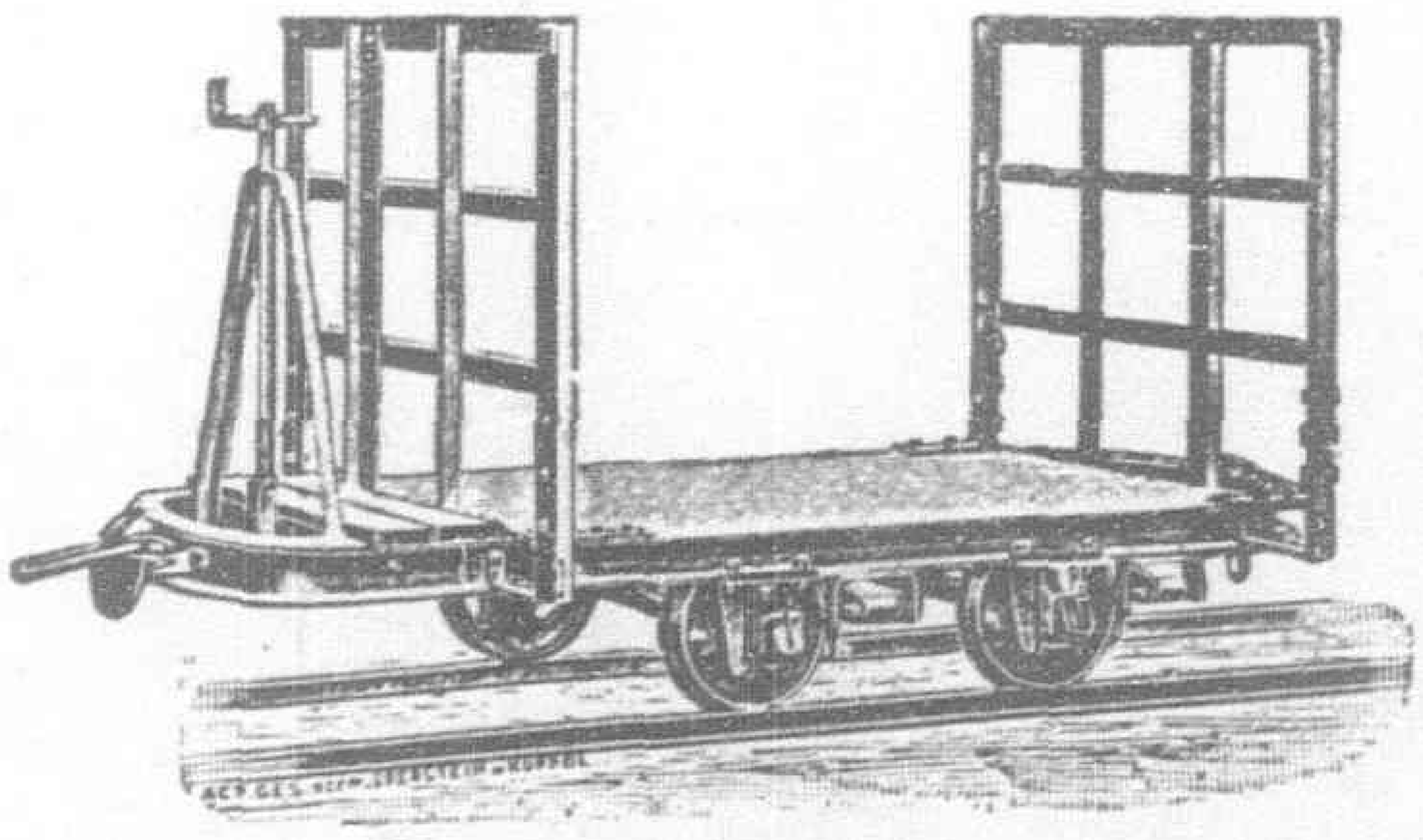

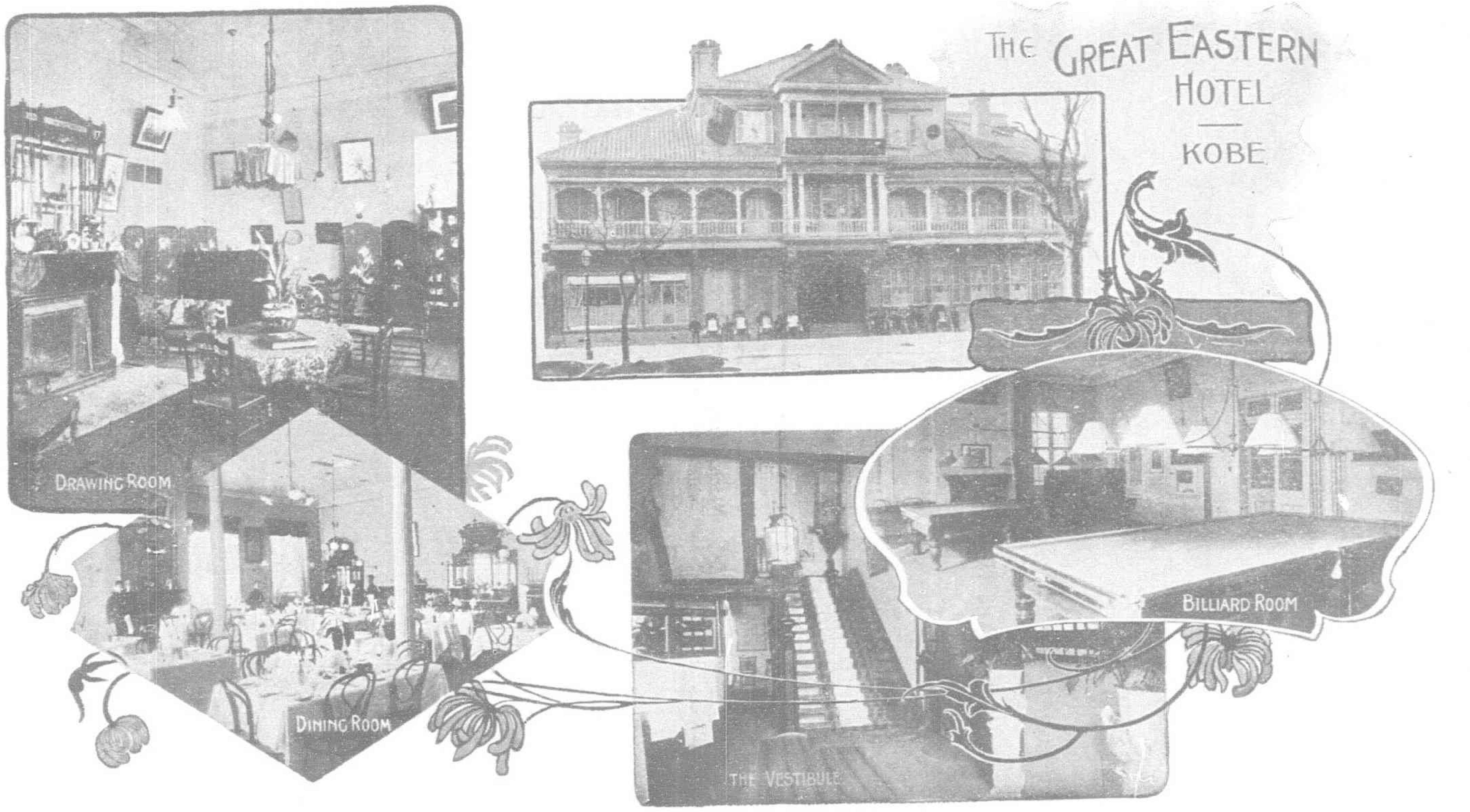

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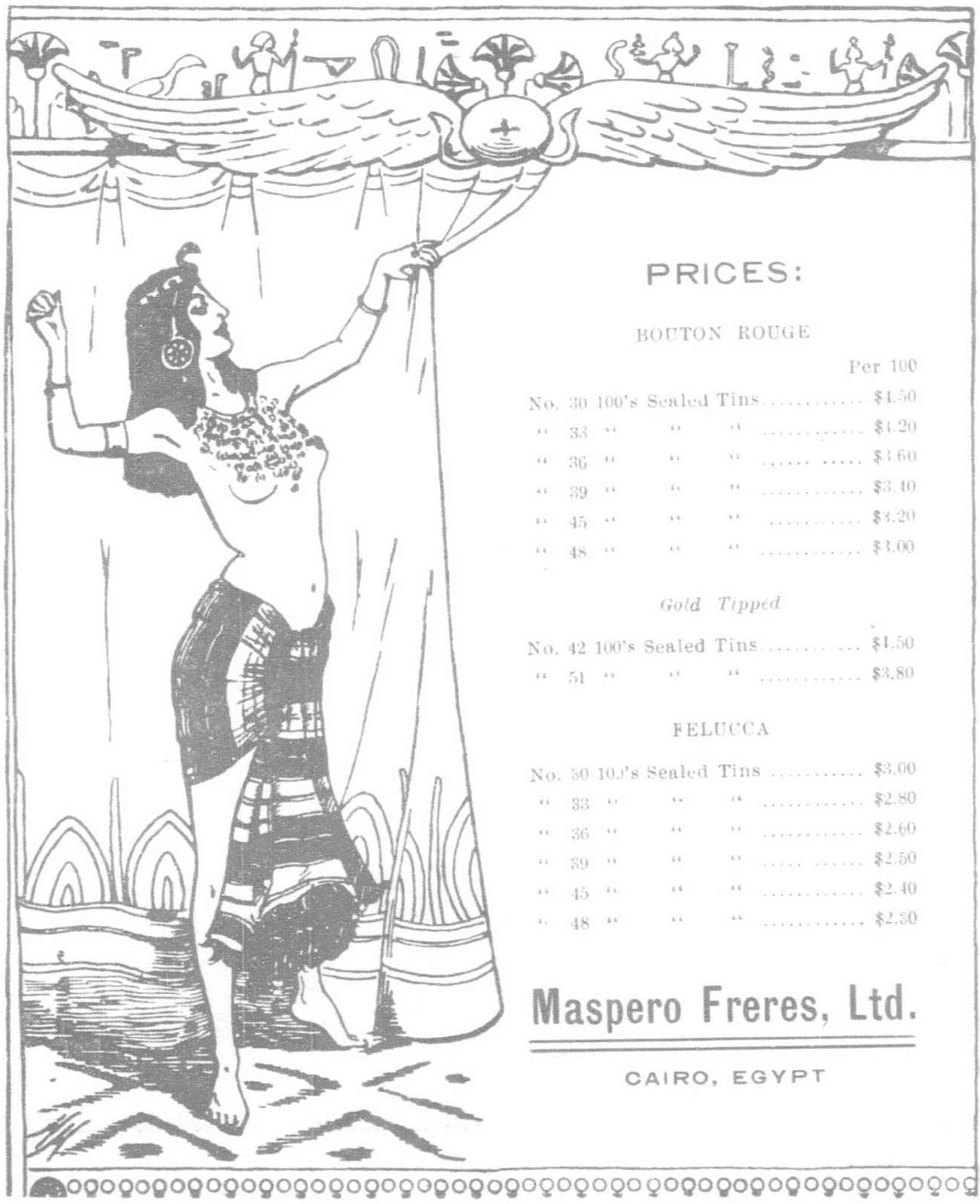

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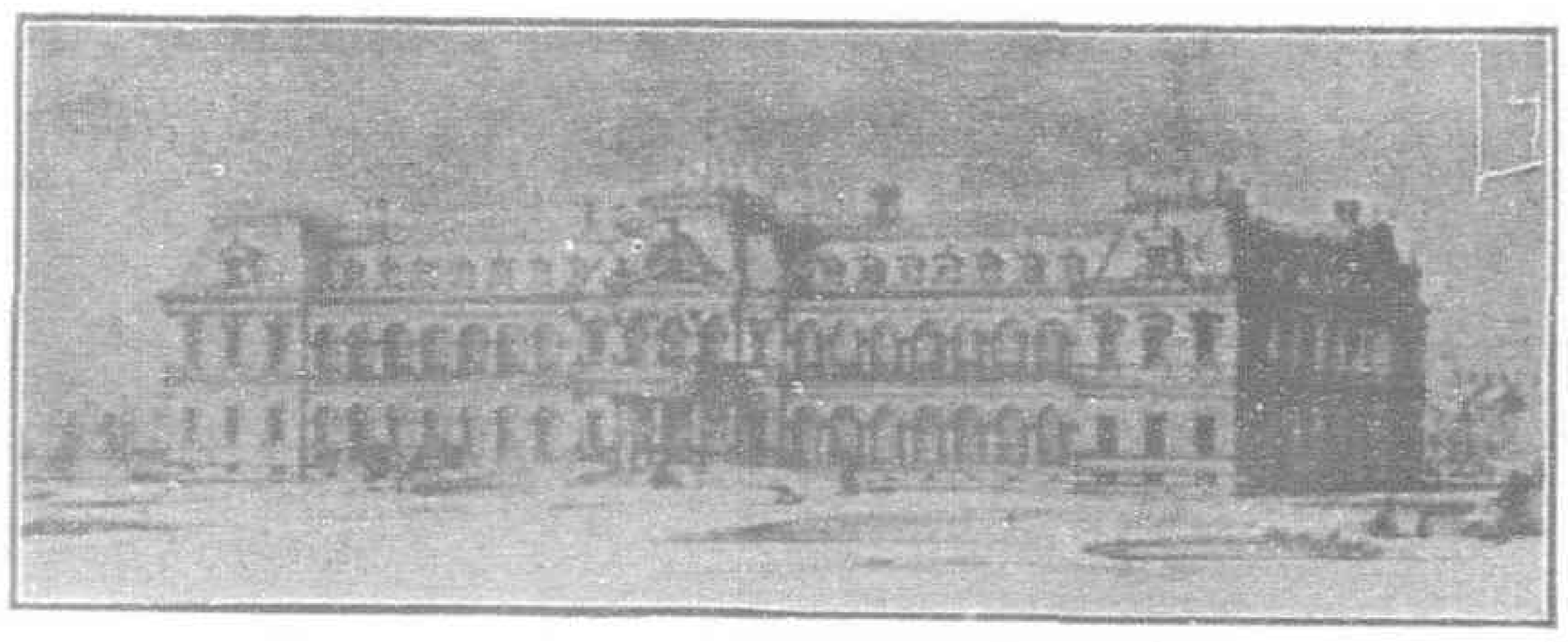

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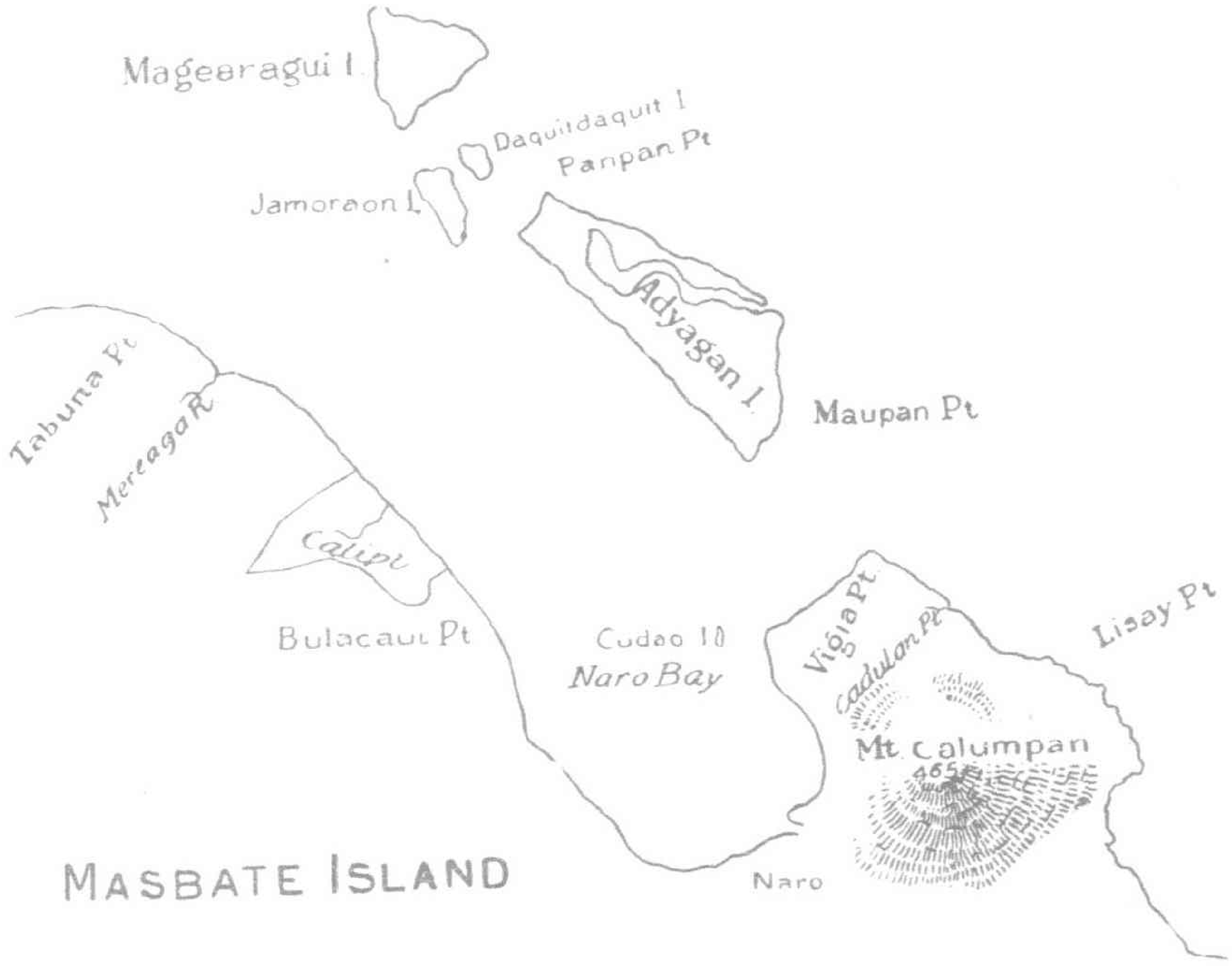

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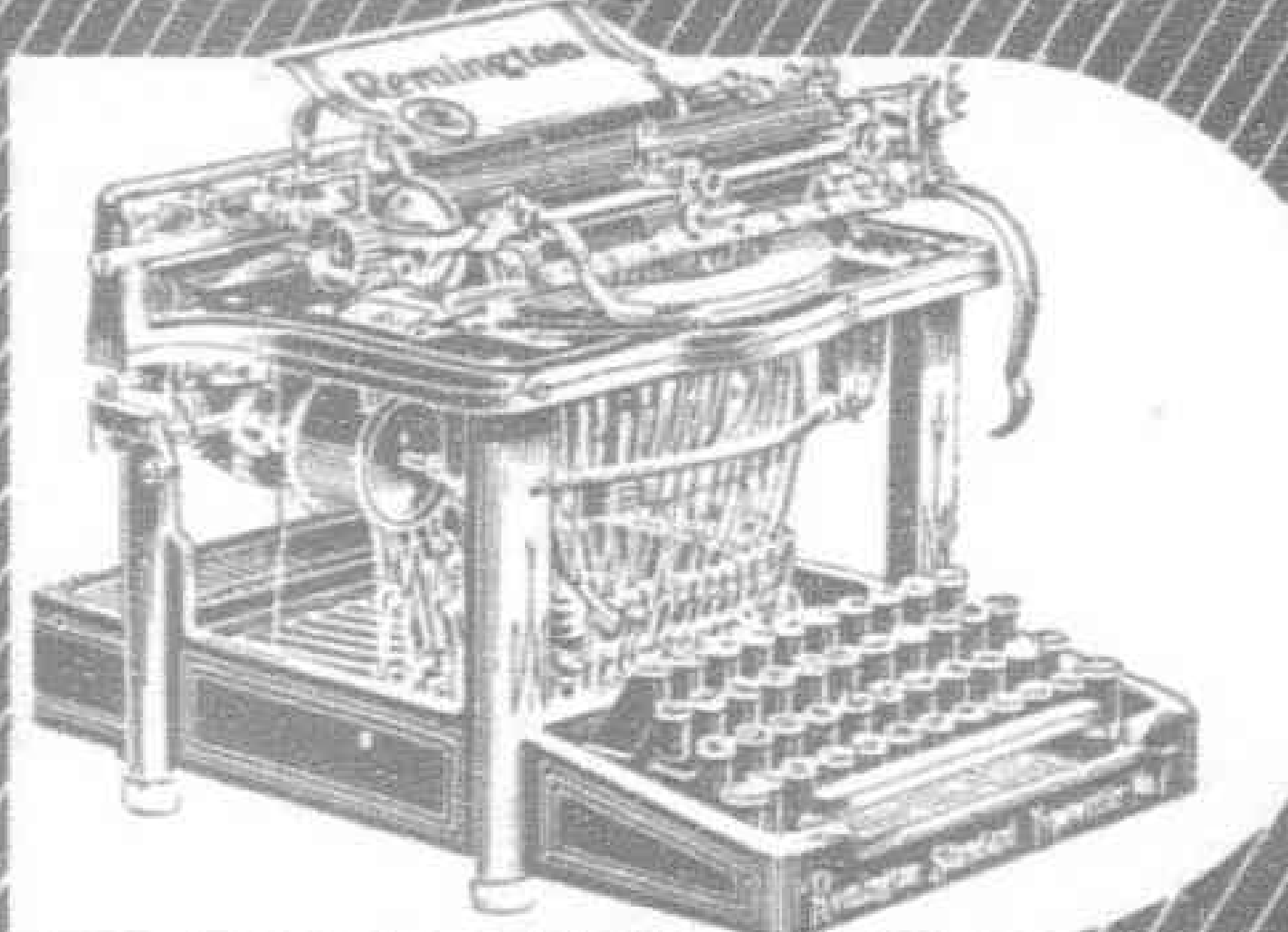

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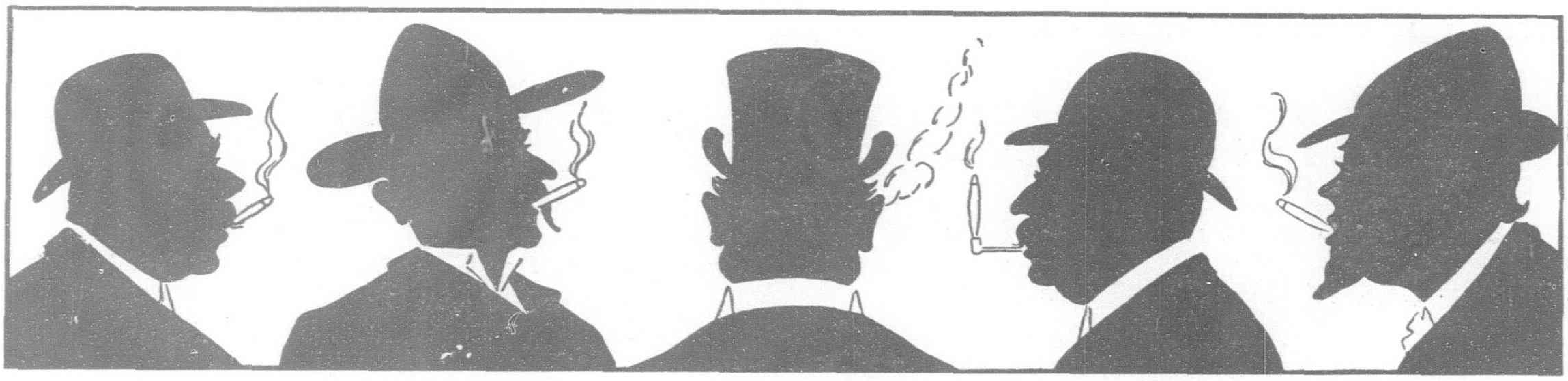

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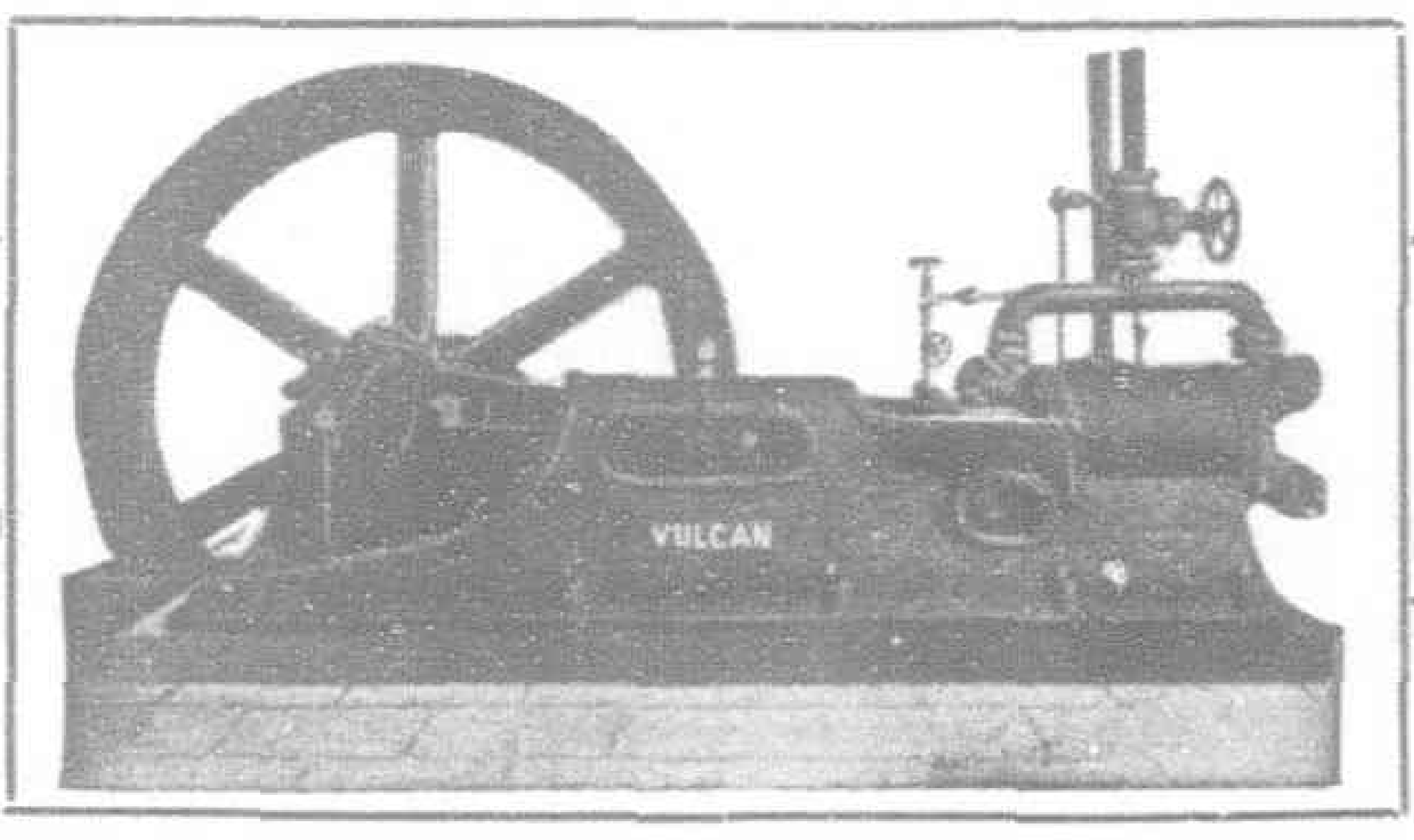

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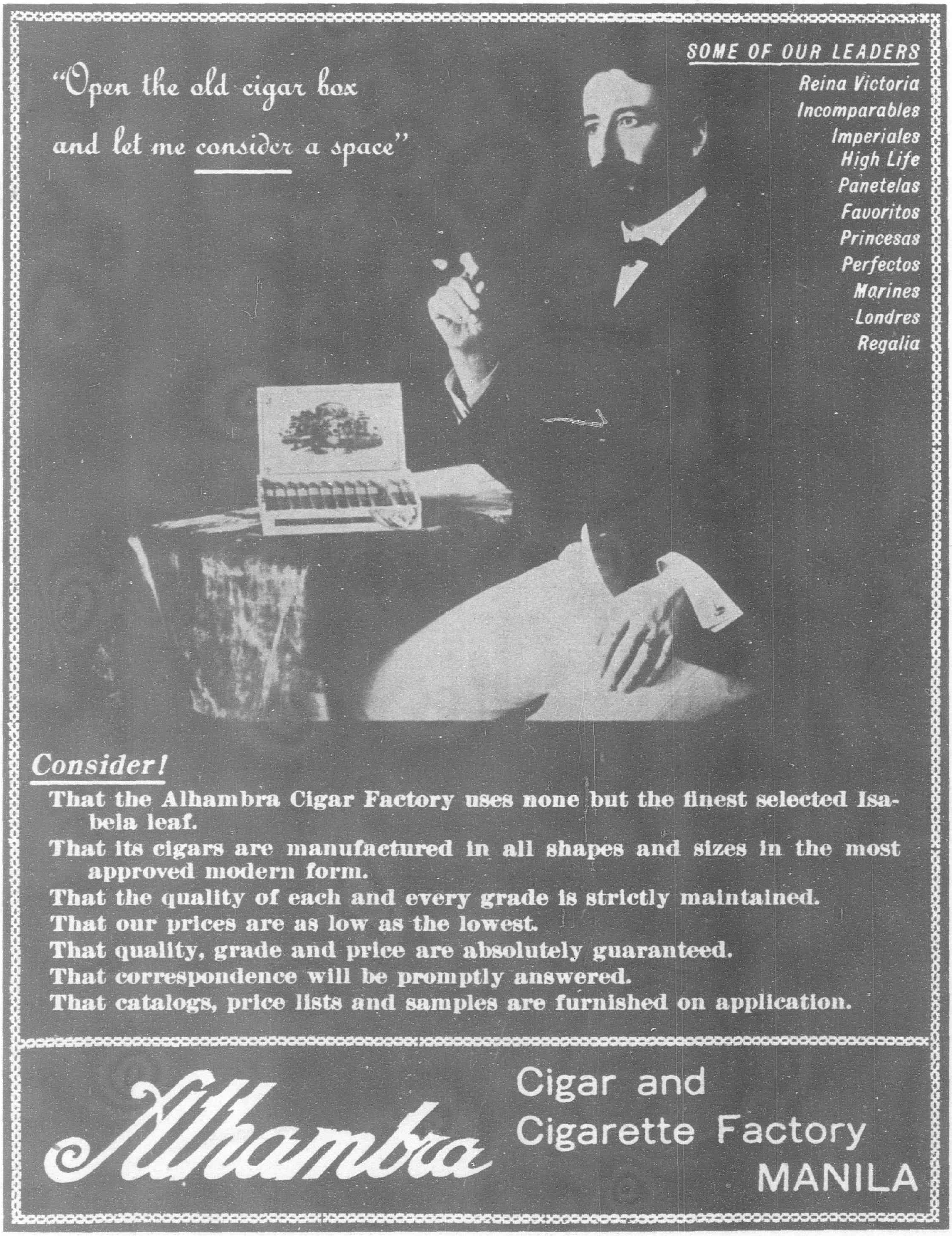

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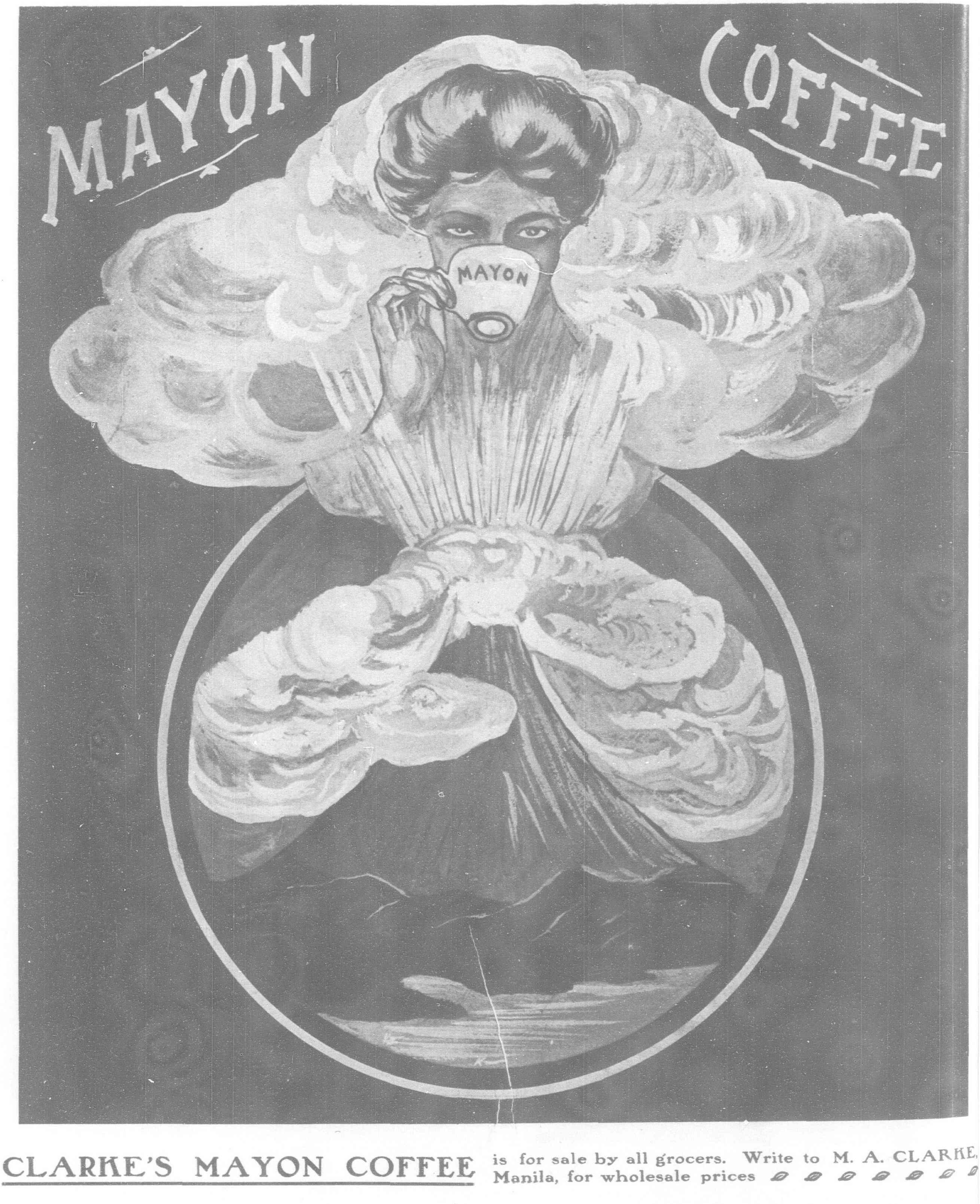

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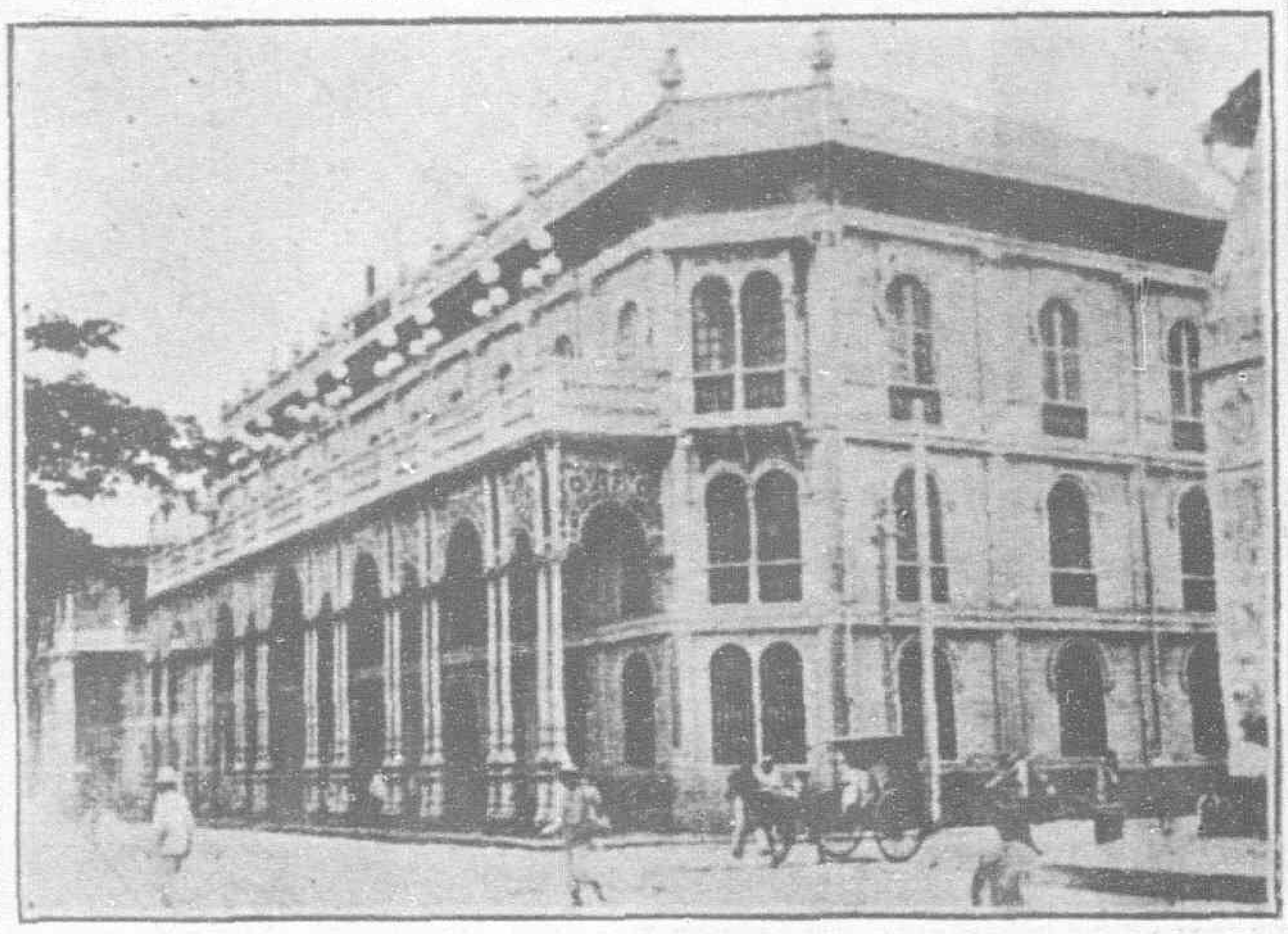

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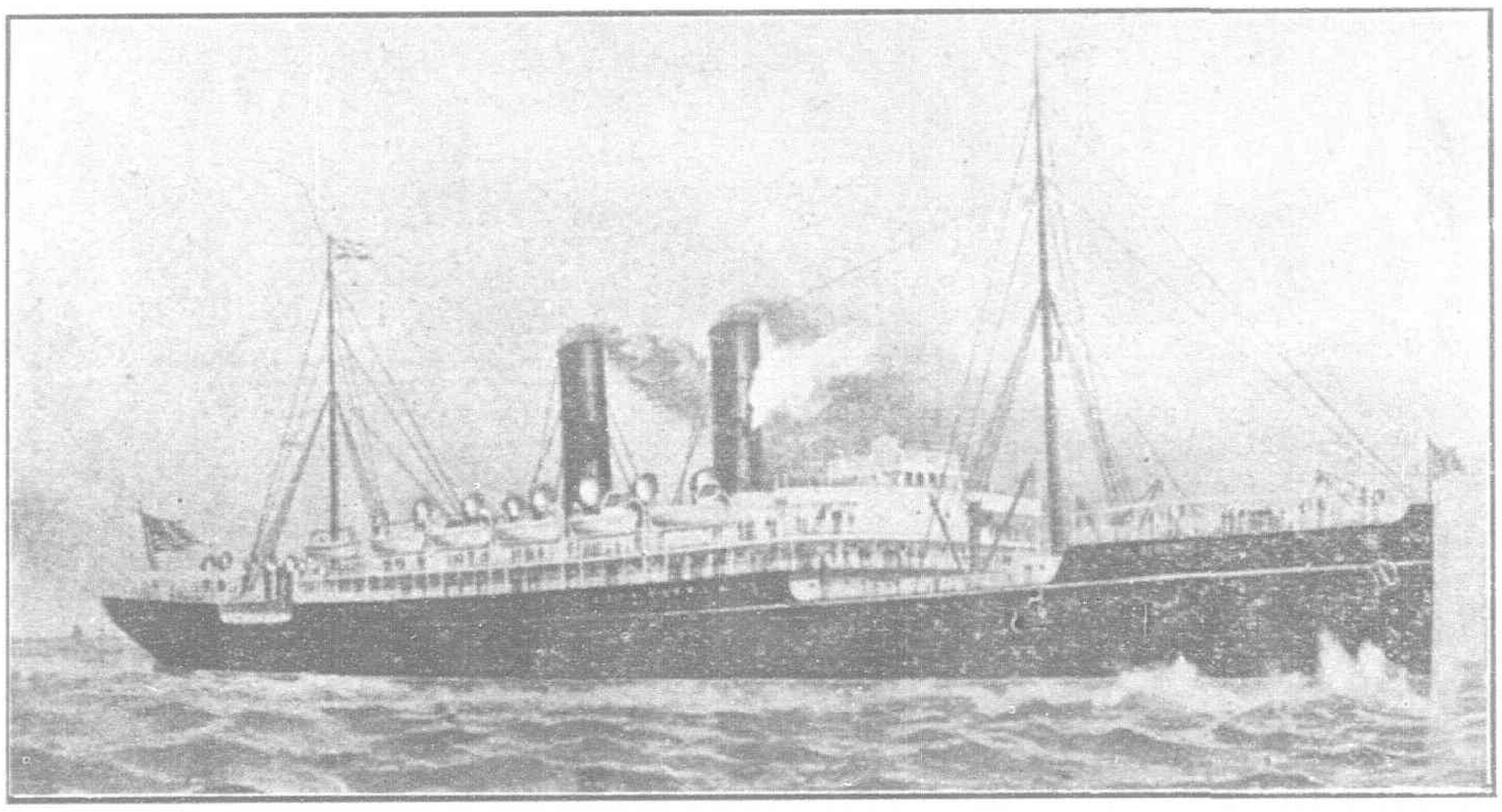

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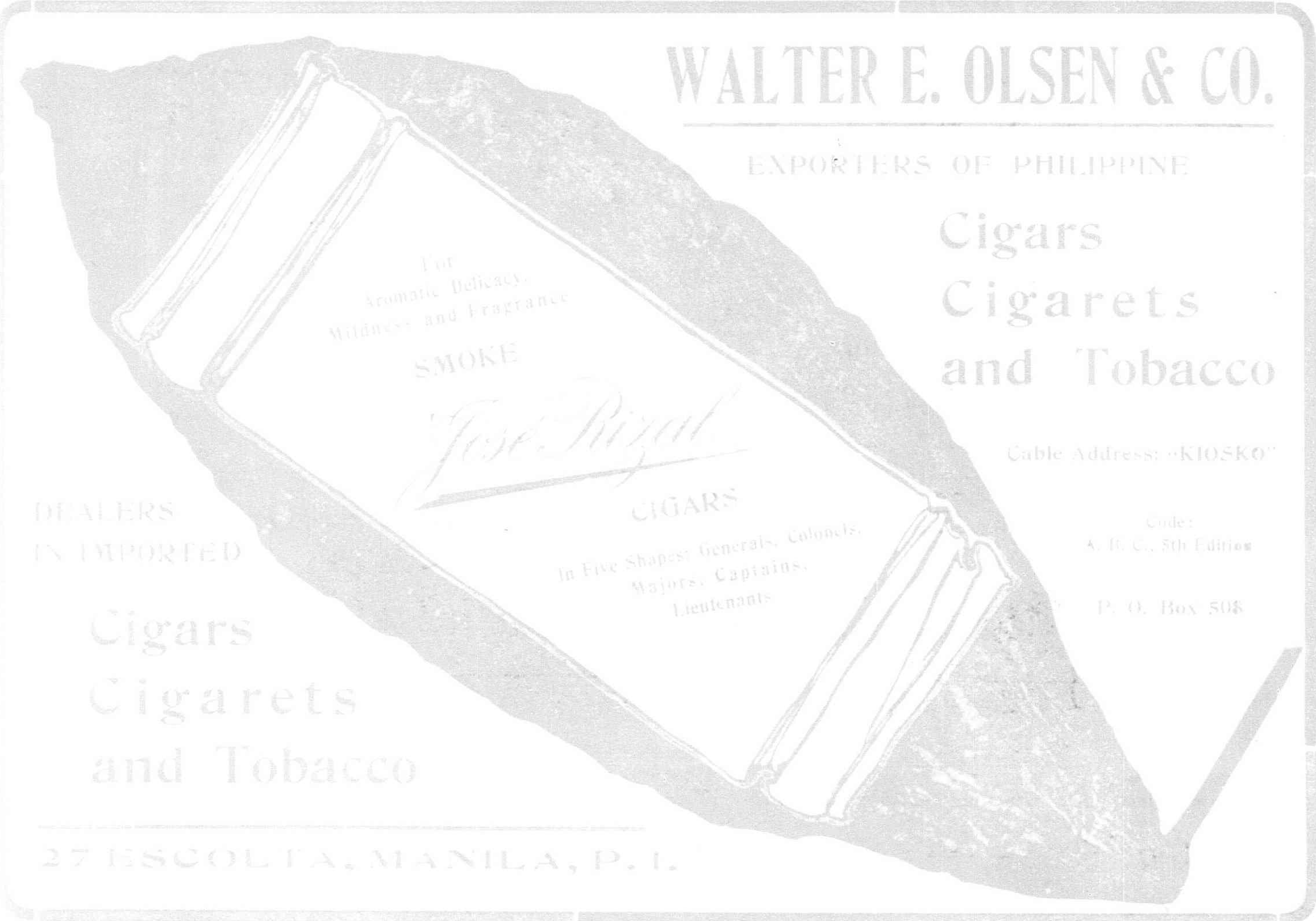

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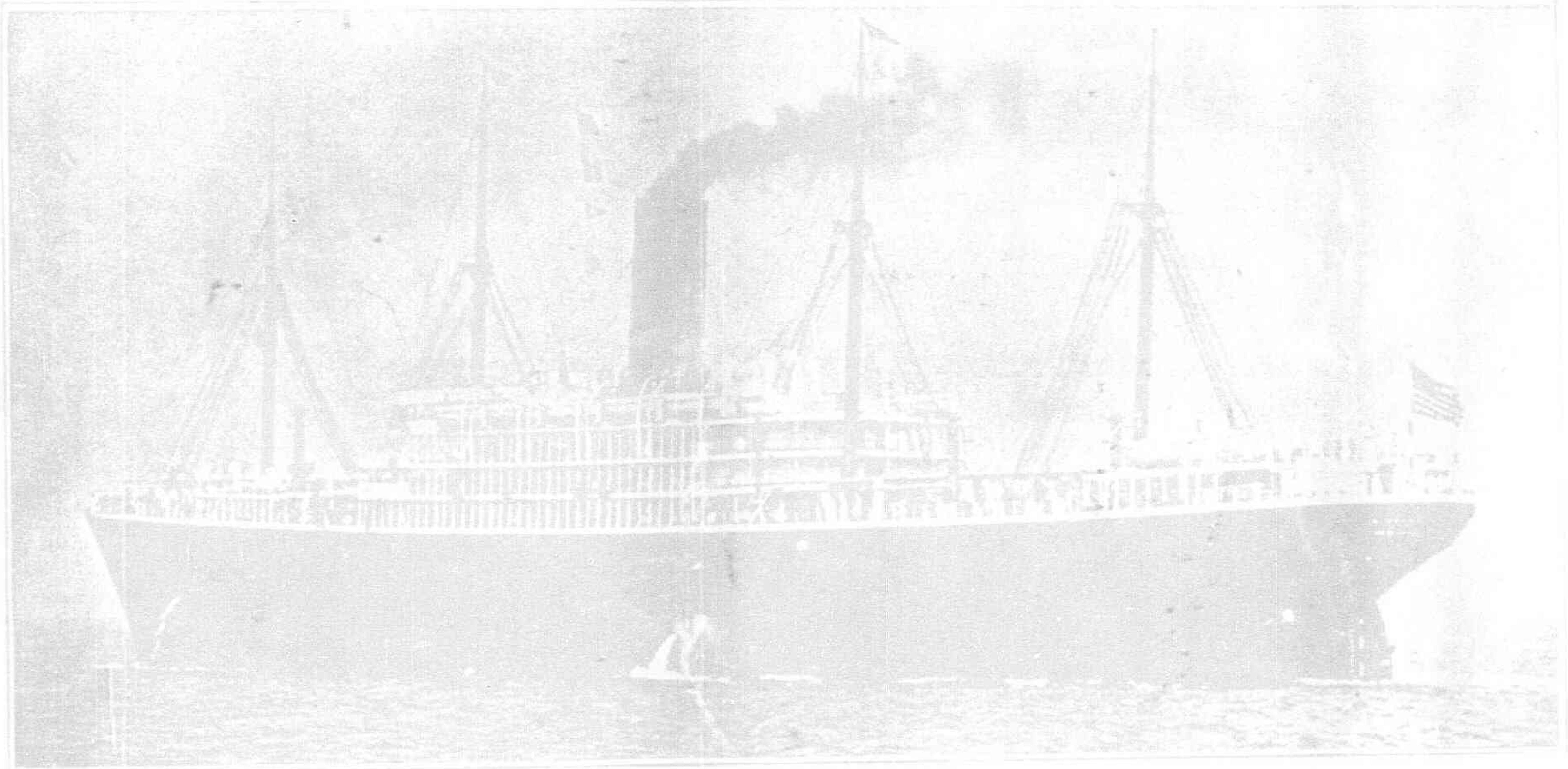

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LEAVE	ARRIVE					STEAMER	LEAVE				ARRIVE	
SEATTLE	YOKOHAMA	KOBE	NAGASAKI	SHANGHAI	HONGKONG		HONGKONG	SHANGHAI	NAGASAKI	KOBE	YOKOHAMA	SEATTLE
Jan. [illegible]	Jan. 25	Jan. 28	Feb. [illegible]	Feb. [illegible]	Feb. [illegible]	MINNESOTA	[illegible]	[illegible]	[illegible]	Mch. 1	Mch. 4	Mch. [illegible]
Feb. 17	Mch. [illegible]	Mch. [illegible]	Mch. 11	Mch. [illegible]	Mch. 21	DAKOTA	Mch. [illegible]	Apr. [illegible]	Apr. [illegible]	April 9	Apr. [illegible]	Apr. [illegible]

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